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PREREQUISITE POLICY MEASURES

NSW Annual Evaluation & Review 2020-21

2020-21 water year

June 2022

Acknowledgement of Country

The Department of Planning and Environment acknowledges that it stands on Aboriginal land. We acknowledge the Traditional Custodians of the land and we show our respect for Elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

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More information

Environmental water hub | Prerequisite policy measures

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We acknowledge the contribution of the NSW Prerequisite Policy Measures Working Group and their respective agencies, including WaterNSW, NSW Department of Planning and Environment – Environment and Heritage, Commonwealth Environmental Water Office and Murray-Darling Basin Authority.

Cover image: Edward River, Murray Valley National Park – James Dyer.

Abbreviations

Abbreviation	Description
CEWH	Commonwealth Environmental Water Holder
CEWO	Commonwealth Environmental Water Office
DPE-E&HG	Department of Planning and Environment – Environment and Heritage Group (previously Environment, Energy and Science)
DPE-Water	Department of Planning and Environment – Water Group
EWAG	Environmental Water Advisory Group
EWC	Environmental Water Committee (Tier 1)
EWIG	Environmental Water Improvement Group
HEW	Held Environmental Water
MAA	Murray Additional Allowance
MDBA	Murray-Darling Basin Authority
MIL	Murray Irrigation Limited
MLS	Menindee Lakes System
PEW	Planned Environmental Water
PPM	Prerequisite Policy Measure
RMIF	River Murray Increased Flow
SCBEWC	Southern Connected Basin Environmental Watering Committee
TLM	The Living Murray

Preface

This report is the second annual review of prerequisite policy measures (PPMs) implementation in NSW. It examines the PPM environmental watering actions within NSW jurisdiction during the 2020-21 water year.

Significant advancements were achieved in the ongoing implementation of PPMs in NSW during 2020-21, including:

- five separate environmental watering actions that relied on PPMs in the Lower Darling, Murrumbidgee and Edward/Kolety-Wakool river systems
- the application of incremental losses to return flows from the Murrumbidgee into the River Murray for recognition at the South Australian border, and
- ongoing collaboration and cooperation between the river operator and the environmental water holders to develop and deliver environmental water.

There are also some areas that could be improved:

- progressing an evaluation framework for determining how PPMs provide for the efficient and effective use of held environmental water
- streamlining processes to provide clarity and consistency for decision making, risk assessments, consultation, timing and water planning, and
- updating the procedures manuals to reflect the outcomes of the above two items and to include any new information based on the first two years of implementation of PPMs.

The PPM Working Group has developed a comprehensive annual work plan for PPMs that identifies and prioritises ongoing work items for PPM implementation, including reporting and communication commitments, watering priorities and technical tasks for each system where PPMs apply. Recommendations from this report are included in the annual work plan.

Summary of recommendations

[Follow the link on the R. numbers below for more detail of review recommendations]

R.1 That an evaluation framework be developed for PPMs that includes guidance on how to determine whether PPMs and supporting actions contribute to the efficient and effective use of environmental water.

R.2 That NSW develop a policy on PPMs from Menindee Lakes System when under NSW control.

R.3 That the Edward/Kolety-Wakool seasonal loss accounting treatment be reviewed using data from the 2019-20 and 2020-21 watering events.

R.4 That NSW update the annual environmental release river operation report template to specifically include details on risk assessment and mitigation.

R.5 That an assumed use template is agreed on and implemented, or progress an alternative process that documents the necessary data, methods and assumptions, as soon as possible.

R.6 That the PPM process be streamlined to include fit-for-purpose water ordering and documentation of risks and mitigation measures.

R.7 That the use of MIL escapes for return flows be retained on the work plan for further consideration.

R.8 Review and update the consultation requirements outlined in the procedures manuals to clarify agency responsibilities and stakeholder expectations.

R.9 Update the NSW PPM work plan to include recommendations from this annual review report and tasks prioritised in light of other high priority PPM tasks as determined by the PPM Working Group.

R.10 DPE-Water to progress a review of the procedures manuals and update as necessary to reflect new actions and the outcomes of recommendations.

These recommendations will be incorporated into the PPM work plan. The work plan is maintained by DPE-Water and regularly reviewed by the PPM Working Group to identify and prioritise tasks, particularly as resource conditions change.

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1. Introduction

Prerequisite policy measures (PPMs) are legislative and operational rule changes introduced as part of the Basin Plan. The changes are designed to support the effective and efficient use of held environmental water (HEW) in the Murray Darling Basin southern connected system.

The Murray-Darling Basin Authority (MDBA) assessed PPMs as being in effect in NSW from 1 July 2019. The PPM assessment reports for all Basin states are available on the MDBA website at:

Prerequisite policy measures | Murray-Darling Basin Authority (mdba.gov.au).

In NSW, PPMs are being implemented in the NSW Murray and Lower Darling and the Murrumbidgee regulated rivers. The NSW Government has adopted an adaptive management approach to support continuous improvement in PPM implementation and environmental water delivery in these river systems. More detailed information on the background and implementation of PPMs in NSW is available on the website of the Department of Planning and Environment – Water Group (DPE-Water, or 'the department'):

Prerequisite policy measures | Environmental water hub | NSW Government (industry.gov.au).

This report presents the findings and recommendations from the annual evaluation and review ('the annual review') of the implementation of PPMs in NSW during the 2020-21 water year, from 1 July 2020 to 30 June 2021. The annual review is a key component of the NSW Government's commitment to the ongoing implementation of PPMs.

The review was conducted by DPE-Water, with input from the Department of Planning and Environment – Environment and Heritage Group (DPE-E&HG), WaterNSW, Commonwealth Environmental Water Office (CEWO) and the MDBA.

The purpose of the annual review is to:

- support continuous improvement of PPMs processes to improve environmental water management, and
- provide transparency about the use of PPMs in 2020-21.

This annual review report focuses on enviornmental watering actions that use PPMs (i.e. piggybacking or return flow recognition) under NSW (only) jurisdiction. Although there were multi-jurisdictional PPM environmental watering actions during 2020-21, assessment of these is beyond the scope of this review.

This annual review report will be submitted to the MDBA as part of NSW's requirement under the Basin-wide Environmental Water Protection Strategy and Implementation Plan.

The annual review is not designed to make an assessment of environmental benefits resulting from the PPMs watering actions, nor a description of those benefits. Reporting on the use of water for the environment is a matter for separate consideration by the environmental water holders and their respective agencies (see Use of water for the environment in NSW: Outcomes 2020–21 | NSW Environment and Heritage).

2. Requirements for the annual review

The matters for consideration in the annual review are set out in Section 5.2 of the *Prerequisite Policy Measures: Procedures Manual for the NSW Murray and Lower Darling Regulated Rivers*[1] and the *Prerequisite Policy Measures: Procedures Manual for the Murrumbidgee Regulated River*[2] ('the procedures manuals').

This 2020-21 review was conducted in accordance with these requirements, including consideration of reports provided by the river operator and environmental water manager that document the environmental watering actions. These are the:

- Annual Environmental Release River Operations Report (Appendix A) that documents the application of specific agreed actions, trial actions, and associated supporting measures, including the accounting of river flows, transmission losses, and water delivery that occurred, and
- Annual Environmental Watering Statement (Appendix B) that documents any issues that arose in the ordering or delivery and accounting of environmental water using the agreed and trial actions.

Table 1 outlines the matters from the procedures manuals that the annual review is required to consider and the relevant section of this report that addresses those requirements.

Note that the procedures manual requires this annual evaluation and review report to include consideration of the results and recommendations of the reporting elements provided by the river operator and environmental water manager. Rather than address these elements as a separate section in this report, they have been captured under the relevant matters for consideration in Section 4 below.

[1] https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/234367/ppms-procedures-manual-nsw-murray-lower-darling.pdf

[2] https://www.industry.nsw.gov.au/__data/assets/pdf_file/0008/234368/ppms-procedures-manual-murrumbidgee.pdf

Table 1: Matters for consideration in the annual review

Matters for consideration	Section of this report
• whether the current PPM actions and the associated supporting measures provide for the effective and efficient use of held environmental water	Section 4.1
• whether there are sufficient mitigation measures in place and whether they have been effective	Section 4.2
• whether general operational procedures were followed for the delivery of HEW via PPMs.	Section 4.3
• whether the actions and associated supporting measures should be expanded, modified, or remain unchanged	Section 4.4
• any proposals for variations or new actions and/or supporting measures that may be brought forward by the river operator or the environmental water holder	Section 4.4
• any issues relating to PPMs raised through consultation with stakeholders in the valley	Section 4.5
• the results and recommendations of the reporting elements provided by the river operator and environmental water manager o Appendix A Annual Environmental Release River Operations Report o Appendix B Annual Environmental Watering statement	Addressed under relevant headings in Section 4 Findings & recommendations
• reporting on the implementation of improvements from previous review, including consideration of recommendations provided by the PPM Working Group	Section 4.6

The PPM work plan for the 2020-21 water year is provided in Appendix C.

3. PPM actions undertaken in NSW in 2020-21

The 2020-21 water year saw some improvements in rainfall and inflows, with increased allocations compared to the previous water year providing greater opportunities for using PPMs. In the Murrumbidgee, general security licences started the water year with a 14% allocation which had increased to 100% by January. In the NSW Murray, there was no opening allocation to general security licences but by June allocations had increased steadily to reach 50%. Allocations to high security licences in the Murrumbidgee and NSW Murray at the start of the water year were 95% and 97% respectively. General security licences in the Lower Darling commenced on 30% and reached 100% in April 2021.

Five PPMs environmental watering actions were undertaken under NSW jurisdiction in 2020-21, three of which were in the NSW Murray and Lower Darling Regulated Rivers system (including the Edward/Kolety-Wakool system). Two actions were undertaken in the Murrumbidgee Regulated River system:

- Lower Darling River fish flows (LOD20/21-01)
- Lower Darling River autumn - winter flows (LOD20/21-02)
- Murrumbidgee native fish pulses (November 2020 and May 2021) (MBG20/21-11), and
- Edward/Kolety-Wakool system delivery (MUR20/21-03).

The locations of these actions are shown in Figure 1. Table 2 provides further details for each event.

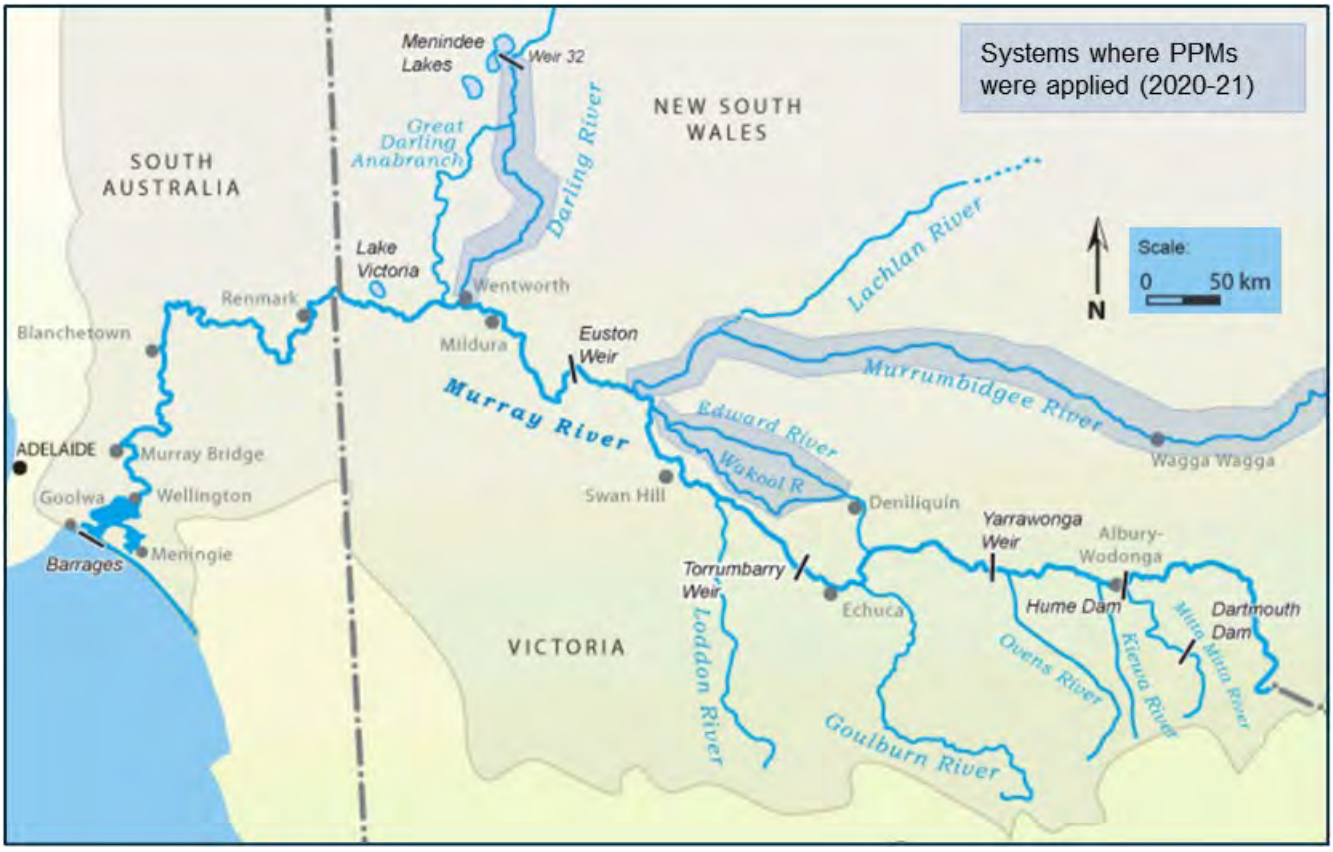


Figure 1: Locations of environmental watering actions that used PPMs in NSW during 2020-21 water year

Table 2: Summary details of the environmental water actions that used PPMs undertaken in 2020-21

Details	Name of environmental watering action that used PPMs				
	Lower Darling fish flows	Lower Darling autumn - winter flows	Murrumbidgee native fish pulse #1	Murrumbidgee native fish pulse #2	Edward/Kolety-Wakool River system
DPE-E&HG event number	LOD20/21-01 (see Section 3.1)	LOD20/21-02 (see Section 3.1)	MBG20/21-11 (see Section 3.2)	MBG20/21-11 (see Section 3.2)	MUR20/21-03 (see Section 3.3)
Targeted valley	Lower Darling	Lower Darling	Murrumbidgee	Murrumbidgee	Murray (Edward-Wakool system)
Overview of environmental watering action	In-stream delivery of operational and environmental water (elevated based flows and small freshes) to provide increased habitat and suitable conditions for native fish breeding and recruitment		Moderate in-channel pulse targeting native fish movement and recruitment, productivity and instream vegetation		Base flows and freshes in the Yallakool, Upper Wakool and Colligen Creek-Niemur River for native fish breeding and recruitment
Environmental site/s watered	Lower Darling channel (Weir 32) Lower Darling channel (Burtundy Weir)		Murrumbidgee River channel		Yallakool-Wakool Reach Niemur wetland
Delivery start date	September 15, 2020	May 1, 2021	November 9, 2020	May 9, 2021	October 21, 2020
Delivery end date	January 17, 2021	June 30, 2021	November 16, 2020	May 29, 2021	May 8, 2021
PPM action	Directed release Return flow recognition requested but denied by NSW[3]	Directed release Return flow recognition	Directed release Return flow recognition (with tributary inflows)	Directed release[4] Return flow recognition (with tributary inflows)	Diversion of operational water (in lieu of return flow recognition)[5]

[3] Return flow recognition was requested but denied by NSW over summer 2020-21. See Section 4.1 of this report for further detail.

[4] November event was delivered on top of an inter-valley trade (IVT) delivery

[5] The agreed interim accounting for environmental water delivery in the Wakool system uses operational water only, consisting of a seasonal loss rate and a seasonal loss threshold.

Details	Name of environmental watering action that used PPMs				
	Lower Darling fish flows	Lower Darling autumn - winter flows	Murrumbidgee native fish pulse #1	Murrumbidgee native fish pulse #2	Edward/Kolety-Wakool River system
Assumed use method / accounting method	*Determination of debit:* additional releases from storage, calculated as the difference between actual releases and those estimated to have been made without the environmental water order (operational requirement) Minimum of: • The target flow +10% minus required operational flow, or • The observed flow minus required operational flow *Determination of return flow (end of Lower Darling)*: Proportional loss rate (6%) (LOD20/21-02 only) *Determination of return flow (SA border)*: Incremental loss rate (look up table), proportional losses when environmental water component < 500 ML/day (LOD20/21-02 only)		*Determination of debit:* additional releases from storage, calculated as the difference between actual releases and those estimated to have been made without the environmental water order (operational requirement including intervalley trade) Minimum of: • The target flow +10% minus required operational flow, or • The observed flow minus required operational flow *Determination of return flow (end of Murrumbidgee):* As the environmental water target flow was referenced at the end of system (downstream Balranald Weir), in-channel losses were socialised[6] *Determination of return flow (SA border)*: Incremental loss rate (look up table)		*Determination of debit:* A seasonal loss rate is applied to all environmental water inflows that exceed the seasonal loss threshold. EWHs also debited for the balance of any environmental flow required on top of operational requirements to meet the loss threshold. *Determination of return flow:* Not application for this event
Interim or agreed action	Not applicable for this event	Interim	Interim	Interim	Interim
Total volume of water delivered to support environmental watering	Target e-water hydrograph: 59,800 ML Actual hydrograph achieved: 58,070 ML[7]	Target e-water hydrograph: 14,000 ML Actual hydrograph achieved: 13,292 ML[7]	Actual hydrograph achieved: 40,007 ML	Actual hydrograph achieved: 66,408 ML[8]	47,053 ML[9]
Volume of held environmental water debited	24,852 ML (11,187 ML CEWH, 13,665 ML TLM)	7,443 ML (647 ML CEWH, 6,795 ML TLM)	30,000 ML (TLM)	36,017 ML (30,000 ML TLM, 6,017 ML CEWH)	13,278 ML (ordered system delivery environmental water)[10]

[6] There was an additional system loss of 3,049 ML incurred below Redbank Weir due to the opening of Yanga Creek regulator and Tala Escape. These losses were "made good" by placement of additional environmental water orders post-event. The additional water orders were reconciled based on flow measurements provided by DPE-E&HG.

[7] Based on the actual flows at Weir 32 and includes required operational flows. Note that there were calls by RMW operations from 15 May to 16 June 2021 (57,765 ML), which meant that environmental water orders were suspended for that duration. There was no official cancellation of water orders.

[8] Includes 28,279 IVT delivery to the River Murray.

[9] Includes 13,278 of ordered system delivery environmental water, 21,385 ML from multi-site Murray watering and 12,390 ML system operational water.

[10] An additional 21,385 ML was debited from the multi-site Murray event, bringing the total debited volume of environmental water to 34,663 ML.

Details	Name of environmental watering action that used PPMs				
	Lower Darling fish flows	Lower Darling autumn - winter flows	Murrumbidgee native fish pulse #1	Murrumbidgee native fish pulse #2	Edward/Kolety-Wakool River system
Return flow volume recognised (after losses applied)	Not applied to this event (see Section 4.1 for more detail)	Volume recognised at Burtundy: 6,998 ML Volume recognised at SA border: 5,610 ML	29,188 ML	30,398 ML	Not applicable for this event[11]

[11] As agreed under the interim accounting method, all releases for this event were made from Murray storages. The environmental water holders are debited for the net use of operational water diverted through the Edward/Kolety-Wakool to meet the environmental flow targets, as such there are no return flows of environmental water.

3.1 Lower Darling River

Two PPM actions were undertaken in the Lower Darling River. The fish flow event (LOD20/21-01) occurred during September 2020 to January 2021. The flow supported Murray Cod breeding by increasing the river flow through the breeding season. Recent monitoring confirmed strong breeding by Murray Cod in the spring of 2020, with high numbers of juveniles now present in the Lower Darling. This event aimed to support native fish recovery particularly Murray cod following the fish kills of 2019. Return flows were not recognised for this event over summer 2020-21 (see Section 4.1 for further discussion).

The second Lower Darling River environmental watering event (LOD20/21-02) provided autumn and winter flows (May to June 2021) to support Murray Cod recruitment following a strong breeding response in spring. This event relied on PPMs to provide recognition of held environmental water from Menindee to the South Australian border (environmental return flows).During both events, environmental water was delivered on top of other system flows to achieve the desired hydrographs.

3.2 Murrumbidgee

Two Murrumbidgee events provided pulse flows for native fish over two separate periods. The first fish pulse of 30 GL in November 2020 (MBG20/21-11) was planned to coincide with high flows in the River Murray to facilitate higher flow outcomes, as well as to remove Balranald Weir for around 10-15 days to provide fish passage along the Lower Murrumbidgee River to Redbank Weir. A second fish pulse of a similar volume was delivered in May 2021. CEWH water was also committed to either partially fill Yanga Lake or add to the fish pulse. Under PPMs, the in-channel fish pulses delivered in the Murrumbidgee were recognised in the River Murray system to achieve downstream outcomes.

3.3 Edward/Kolety-Wakool

The Edward/Kolety-Wakool River environmental watering (MUR20/21-03) delivered baseflows from August 2020 to May 2021 to provide dispersal opportunities for fish, access food resources and use suitable spawning habitats. This event re-used flows delivered as part of the multi-site Hume to South Australia event (outside the multi-site period a separate PPM in-channel use loss rate was applied). Similar to 2019-20, some environmental water delivered for this event was delivered via the Murray Irrigation system and is not covered by a PPM action.

A multi-site Hume to South Australia[12] watering event (MUR20/21-18) also used water from NSW held environmental water (HEW) licences in the Murray Regulated River system (October 15, 2020 to June 26, 2021). A total of 144,421 ML of environmental water was debited. The accounting method used was the difference between releases without environmental water

[12] DPE-E&HG environmental water event number MUR2020/21-18.

(the hypothetical operational requirements) and the delivery of the environmental water hydrograph, using the agreed loss rate for the calculation of return flow[13]. Return flows were used in the Edward/Kolety-Wakool system and recognised to the South Australian border. This multi-jurisdictional Hume to South Australia event was undertaken as part of PPMs in the River Murray System overseen by the joint venture states and is not therefore considered further in this report.

3.4 Other environmental water actions undertaken by NSW in the southern Basin

The department also implemented two (Water Management Act 2000) Section 324 temporary water restrictions14 in the southern Basin during the 2020-21 water year. These temporary water restrictions affected unregulated river access licences in the Tuppal Creek and Thule Creek systems, and in the Buccaneit and Cunninyeuk creek systems from 15 September 2020 to 30 June 2021.

These temporary water restrictions were made to ensure environmental water delivered in these unregulated creeks was not extracted by licence holders. More information can be found at:

1. temporary water restrictions - Buccaneit and Cunninyeuk Creeks, and
2. temporary water restrictions - Thule and Tuppal Creeks.

3.5 Work plan

The PPM work plan for the 2020-21 water year is provided in Appendix C. This work plan was updated throughout the year by the PPM Working Group at every meeting. The work plan is maintained by DPE-Water and was regularly reviewed throughout the water year by the PPM Working Group to identify and prioritise tasks. The resources available for PPMs are distributed based on the priority tasks identified in the work plan.

[13] This accounting method was undertaken in accordance with the Objectives and outcomes for river operations in the River Murray system approved by the Basin Officials Committee.

[14] Section 324 of the Water Management Act 2000 (the Act) allows the Minister or a delegate to direct, by order, that temporary water restrictions within a water source(s) have effect for a specified period if these restrictions are determined to be in the public interest.

4. Findings & recommendations

This section presents the findings of the department's review of PPM watering actions for the 2020-21 water year. The content and structure of this section are in accordance with the requirements for the annual review in the procedures manuals (as described Section 2 of this report). It also draws on the annual reports provided by the river operator and environmental water manager (see Appendix A and Appendix B).

The department consulted with the NSW PPM Working Group regarding the findings and recommendations prior to finalising this report.

In the absence of a detailed evaluation framework, each of the matters required for consideration in the annual review (as listed in the procedures manual, see Section 5.2) are discussed separately below.

4.1 Providing for effective & efficient use of held environmental water

The procedures manuals require an assessment of whether the "PPMs actions and supporting measures provide for the effective and efficient use of HEW". As noted in the 2019-20 review report, the manuals do not define 'efficient and effective'.

The MDBA's Basin-wide Environmental Water Protection Strategy and Implementation Plan maintains environmental water protections must be:

a) efficient: environmental water protections must be comprehensive, consistent, secure, enduring and transparent, and

b) effective: providing simple, operable and cost-effective protection.

4.1.1 Findings

The 2019-20 annual review and evaluation report recommended the procedures manuals be updated to include definitions for 'efficient' and 'effective' use of HEW and to provide clearer advice on how to evaluate whether PPMs and supporting actions contributed to these requirements. This work has not progressed to a stage where it can be applied to the annual review for the 2020-21 water year. Each of the PPM events have been considered against efficient and effective as defined above.

Lower Darling

The two Lower Darling releases occurred as separate PPM events over September 2020 to January 2021, and May to June 2021. Planning for the proposed directed release for fish pulse flows from Menindee Lakes in spring 2020 started in early May, with requests made for directed releases and recognition of return flows in the Murray. At this point in time, both the Lower Darling and NSW Murray were in drought stage 2 (recovering). Although normal regulated river operations had re-commenced in the Lower Darling, the system was being

managed by NSW to ensure enough resource was available to supply landholders and maintain connectivity to the River Murray for at least 12 to 18 months.

All agencies recognised the challenge in balancing the different objectives, delivering account water while providing seasonal minimum flows and optimising system longevity. A number of environmental watering options were put forward; scenario modelling by WaterNSW has indicated that larger pulse flows would bring forward drought actions in the Lower Darling by at least two weeks. It was agreed that a pulse release of up to 400 ML/day (total release up to 16 GL) could be made without materially impacting on longevity of supply.

In May 2020 the request for return flow recognition of HEW from the Lower Darling in the River Murray was denied by DPE-Water (as the resource manager). Table 6 of the Procedures Manual for the NSW Murray and Lower Darling states that:

> *"…when Menindee Lakes ceases to be a shared resource, a PPM proposal … would be considered and assessed … depending on the local circumstances and risks at the time, may not be deliverable."*

Once Menindee Lakes falls below 480 GL, the system is managed essentially as a drought reserve to meet local demands to extend supplies for local critical needs as long as possible. The focus of operations was on maintaining drought reserves to run the system for 12-18 months to provide system longevity. Historically, most account water (including general security) has been supplied to the Lower Darling within seasonal minimum flows without additional release from storage. Seasonal minimum releases are set out in the water sharing plan to maintain water quality and river health. The system is managed to maintain riverine connectivity, and not delivery of water to the Murray. When the Menindee Lakes system (MLS) reverts to NSW control, bulk transfers cease and temporary trade between the Lower Darling and the Murray closes, and typically remains closed until the system recovers to hold more than 640 GL of water.

Without recognition of return flows of HEW, any flows from the Lower Darling into the Murray would be re-socialised as part of NSW Murray resource. General security licences in the NSW Murray started the 2020-21 water year with zero allocation and had increased to 12% at the start of spring. A commitment was given to reviewing the NSW position in July 2020; the department subsequently recommended that once general security allocations in the downstream Murray increased to 30% that return flows be recognised.

The environmental water holders opposed this position on the basis that the environmental outcomes of the flows were targeted for in-stream environmental benefits in the Lower Darling and would be arriving in the Murray regardless. CEWO stated that not recognising return flows will have a major impact on the effectiveness of use of the Commonwealth resource in the Murray, on the understanding the value of CEWO water is closely tied to the ability to use water multiple times to efficiently achieve environmental outcomes. The matter was escalated by the CEWO to the Murray-Darling Basin Ministerial Council (MinCO) and the Basin Officials Committee. The Chair of the Southern Connected Basin Environmental Watering Committee also requested the department recognise return flows, asserting that a modest environmental flow would have minimal impact on managing the storage as a drought reserve and no impact on Murray downstream users.

Not recognising return flows reduces both the efficiency and effectiveness of environmental water released from the Menindee Lakes system, by preventing HEW from being re-used as it flows downstream. Additionally, the lack of a clear position adds to the reduced efficiency of the actions, with no clear and enduring framework for all agencies to work within.

Murrumbidgee

The environmental water accounting methods for return flows outlined in the Murrumbidgee Procedures Manual specify a proportional loss rate will be applied when the Murray River is in regulated conditions, and that the rate will be commensurate with the prevailing conditions, outlook, and level of risk. Under the proportional loss treatment, the total loss for all water delivery was determined and then apportioned to the volumes of environmental water delivered to the Murray.

The bulk of loss in the system is due to normal River Murray deliveries. The Murrumbidgee Procedures Manual identifies the application of incremental losses as a future action for Murrumbidgee end-of-system environmental flows in the Murray. The incremental loss method (Appendix D) was endorsed by the Working Group and applied to return flows in the Murray from the Murrumbidgee in the 2020-21 water year.

An incremental loss method represents the relationship between flows and losses in a loss look-up table. This tables allows the river operator to assign losses for HEW entering the Murray from the end of the Murrumbidgee to determine the volume of HEW to be recognised at the South Australian border.

During the two Murrumbidgee fish pulse events, the environmental water holders were debited a total of 66,071 ML. After applying incremental losses to account for the return flows from the Murrumbidgee, 29,188 ML was recognised in November 2020 and 30,398 ML during May 2021 (total return flow volume recognised at South Australia being 59,568 ML). Return flows from the autumn event supported SCBEWC approved watering actions at TLM sites (Chowilla Floodplain & Lower Lakes, Coorong and Murray Mouth).

Edward/Kolety-Wakool

The interim Edward/Kolety-Wakool seasonal loss accounting treatment was applied for the second year in a row. This approach is based on using (diverted) operational water only and applying a seasonal loss rate and seasonal loss threshold.

The environmental water holder was debited a total of 13,278 ML for the event to provide base flows and freshes from August 2020 to May 2021. The full volume of the desired hydrograph for environmental flows in the system (Wakool River, Yallakool Creek and Colligen Creek) was around 137,000 ML; however, under the interim arrangement the environmental water holders are only debited a seasonal loss rate to all environmental water inflows that exceed the seasonal loss threshold, and for the balance of any flow required on top of operational requirement to meet the loss threshold. In total, the total environmental water debit was 34,663 ML (13,278 ML debited ordered system delivery, and 21,385 ML from the multi-site delivery). These figures indicate how river operators and environmental water managers can work together to manage and delivery water resources efficiently and effectively.

DPE-E&HG have stated that the seasonal loss figures of 70% (spring) and 80% (summer) are very conservative and recommend more accurate measurement of losses in the system. It should be noted that during the development of this loss treatment approach there was consensus by all agencies represented on the PPM Working Group that there was limited confidence in the data available for the system, and this should be considered when prioritising the recommendations from this review and the future work plan (i.e. against developing methods/assumed uses for sites for which there are currently no arrangements in place).

4.1.2 Recommendations

R.1 That an evaluation framework be developed for PPMs that includes guidance on how to determine whether PPMs and supporting actions contribute to the efficient and effective use of environmental water. This framework should also consider any similar work that may be underway either by Environmental Water Improvement Group (EWIG) or the Environmental Water Committee, and have the support of the NSW PPM Working Group.

R.2 That NSW develop a policy on PPMs from Menindee Lakes System when under NSW control and reflect this in the NSW Murray and Lower Darling Procedures Manual. This work will also progress a similar recommendation made by the MDBA during their assessment of PPMs in 2019[15].

R.3 That the Edward/Kolety-Wakool seasonal loss accounting treatment be reviewed using data from the 2019-20 and 2020-21 watering events.

4.2 Risk mitigation measures

The potential risks and mitigation measures associated with the operation of PPMs are listed in Table 7 in the procedures manuals.

The procedures manuals indicate that WaterNSW, in collaboration with DPE-E&HG, is responsible for undertaking risk assessments of proposed actions and recommended mitigation strategies during the planning phase and prior to approval or rejection of water orders.

4.2.1 Findings

The department assumes the river operator (i.e. WaterNSW) completes a risk assessment for the PPM actions as part of its normal operational procedures for water delivery. Similar to the

[15] The MDBA's Priorities for improving Prerequisite Policy Measures (2019) recommended that, to improve how PPM arrangements could be improved, NSW develop arrangements for Menindee Lakes/Lower Darling when under NSW control, including clarifying circumstances under which PPMs may be appropriate in Menindee Lakes under NSW control, and establishing an assumed use method for the lower Darling when Menindee Lakes storage falls below 480 GL.

findings of the 2019-20 annual review, the department has not had access to documentation about risk assessment or mitigation strategies specific to the 2020-21 PPM watering actions. It was therefore difficult to assess whether the mitigation measures were sufficient. The department's template for the Annual Environmental Releases River Operations Report does not specifically request information from WaterNSW about risk assessment or mitigation measures for PPM events. It is noted that Table 6 of the Procedures Manual includes mitigation measures for the different PPM actions.

Similar to the 2019-20 review, the seasonal loss treatment for the Edward/Kolety-Wakool suggests a level of conservatism to mitigate potential impacts to other licence holders and/or operational deliveries.

WaterNSW identified that Balranald Weir could not be re-instated as planned at the end of the Murrumbidgee fish pulse event in May 2021 due to operational issues. The Murrumbidgee native fish pulses were designed to drown out Balranald Weir to provide fish passage in the Lower Murrumbidgee. Balranald Weir typically drowns out at around 3,500 ML/day (3.6 m) at which all dropboards are removed; the boards are replaced when flows drop below 2,000 ML/day (2.5 m). The delay in reinstating the weir has potential impacts on other users, in particular the ability for Balranald Shire Council to pump from the weir pool. Potential impacts on other users relying on Balranald Weir and appropriate mitigation measures should be considered during the planning phases for future events, particularly when typical weir operations are impacted.

As discussed in Section 4.1 above, the decision to not recognise return flows from the Lower Darling during the spring/summer fish pulse event (LOD20/21-01) was not supported by the environmental water holders. Generally, PPM Working Group members were otherwise generally satisfied with delivery and accounting treatments used and no other issues were raised and the 2020-21 environmental watering actions using PPMs were considered to be successfully implemented. This implies that any risks identified by WaterNSW or DPE-E&HG during the planning phase were adequately managed.

Records of any risk assessment performed by WaterNSW and DPE-E&HG would help to ensure transparency and provide for better review and continuous improvement.

4.2.2 Recommendations

R.4 That NSW update the annual environmental release river operation report template to specifically include details on risk assessment and mitigation.

4.3 Operational procedures for PPMs

The general operational procedures for PPMs are set out in the Procedures Manuals. System specific details are provided in section 4 of the procedures manuals for the Murrumbidgee and NSW Murray and Lower Darling.

The operational procedures for PPMs were generally followed for the five PPM watering actions undertaken during 2020-21. Table 3 offers a summary of the operational procedures

followed for actions in each of the systems (noting that multiple events in one system during the water year have been grouped together and any departure from procedure noted).

Table 3: Analysis of operational procedures followed during 2020-21 PPM watering events

Procedure	Lower Darling	Murrumbidgee	Edward/Kolety-Wakool
Planning			
Environmental water holders work together to develop watering schedules	Y	Y	Y
Environmental water holders develop annual environmental watering priorities and plans	Y	Y	Y
Environmental water holders work with WaterNSW to develop a watering proposal, including target flow and location	Y	Y[16]	Y
Ordering and release of water			
DPE-E&HG submits Water Order to WaterNSW	Y	Y[17]	Y
WaterNSW to consider operational risks and mitigation measures when considering water orders	Y	Y[18]	Y
For approved Water Orders, WaterNSW is to operate the river accordingly	Y	Y	Y
For Water Orders that are refused or rejected, WaterNSW is to document the supporting explanations in the Annual Environmental Release River Operations Report[19]	N/A	N/A	N/A
Environmental water manager is required to undertake appropriate communication actions to ensure that potentially affected landholders and the general community are aware of the proposed watering event[20]	Y	Y	Y
WaterNSW to provide operational reporting on release of environmental water, including regular environmental water use accounting during events[21]	Y	Y	Y
Accounting			

[16] While there was consultation between the two agencies for event planning, there is minimal documentation of this planning including any contingency arrangements.

[17] WaterNSW identified an issue with water order provided by DPE-E&HG for the May 2021 Murrumbidgee event

[18] Worst-case risks (such as ability to reinstate Balranald Weir) should be included as part of risk assessment

[19] No orders refused or rejected.

[20] Inferred from Form As, but no specific details provided. The Lower Darling May-June 2021 event mentions TAG only, similar to the Murrumbidgee.

[21] Water use debited as per agreed water accounting treatments.

Procedure	Lower Darling	Murrumbidgee	Edward/Kolety-Wakool
WaterNSW determines and debits volume of held environmental water as a result of environmental watering actions using PPMs	Y	Y	Y
Where there is accurate measurement of take and return, net take of water is debited from account	N/A[22]	N/A[22]	N/A[22]
For sites where measurement is not considered accurate, an Assumed Use method is used to estimate delivery of held environmental water	Y	Y	Y
WaterNSW will provide an Assumed Use Statement, with supporting information including loss rates, source of data use, assumptions and volumes to be debited	N[23]	N	N
Reporting			
WaterNSW will provide an Annual Environmental River Operations Report and relevant supporting information	Y[24]	Y[23]	Y[23]
DPE-E&HG will provide an Annual Environmental Watering Statement and relevant supporting information	Y[25]	Y[24]	Y[24]

4.3.1 Findings

Similar to 2019-20, an agreed format for an assumed use statement has not been finalised; however, the annual environmental release river operations reports provide the accounting approach used and the supporting spreadsheets that detail the accounting approach.

WaterNSW raised two common issues in their reporting:

- the water order process continues to frustrate all parties with the availability of water for delivery, the timeliness of amendments and the necessary feedback of actual use to the customers so that orders can be managed in real time (Murray multi-site, Edward/Kolety-Wakool), and
- water order and debit reconciliation. Debiting did not meet the expectations of the environmental water holders and following 'close of billing' amendments were requested. This consumed significant time and resources to understand the issue and seek correction (e.g. both events in the Lower Darling).

[22] Inaccurate measurement for both events – agreed loss treatments applied.

[23] Agreed format for Assumed Use Statements to be finalised.

[24] Annual Environmental River Operations Reports provided by WaterNSW in early February 2021

[25] Annual Environmental Watering Statement provided by DPE-E&HG in late November 2021. Form As only provided as supporting information

A number of operational issues were also identified by WaterNSW in their reporting the Murrumbidgee events:

- the November 2020 event was operationally challenging for WaterNSW to deliver as supplementary access was happening at the same time
- for the same event, there were other environmental water events upstream of Balranald that impacted the flow peaks at Balranald desired by the environmental water holders
- for the May 2021 event, WaterNSW stated that a clear plan for apportioning usage between different licences was not provided which meant there was not clarity regarding debiting, and
- the May 2021 event was a piggyback event on top of an inter-valley trade (IVT) delivery and therefore the daily flow volumes were very subjective. Further, the Tala Escape and Yanga Regulator were open leading to additional losses in the system.

WaterNSW has recommended that a pre-approved watering plan is provided by the environmental water holders which includes access licence splits and a contingency budget. This plan can be provided during the water order process prior to the start of the event.

Both the river operators and environmental water holders have indicated that the existing standard water order form does not allow all the necessary details of an environmental watering event to be captured. It is noted that there are legislative requirements regarding submitting water order form for the take of water, as well as the E&D governance process requires water order forms to be signed manually before an order is placed.

During the development of this report, there were also discrepancies in water use volumes reported by the agencies. Some differences could potentially be attributed to timing (for example, if the final accounting for an event was not available until after the end of the water year after portfolio accounting had already been undertaken). The delivery instruction, ordering, joint accounting and reporting processes for these environmental watering events that use PPMs remain complex and highlights the need for ongoing streamlining of processes, clear event planning and water ordering, improved communications and regular and timely within- and post-event accounting.

Work has commenced on a PPM implementation process and was discussed by the PPM Working Group (meeting 6, October 2021). This process, which attempts to clearly identify timing and responsibilities, has yet to be tested and still relies on the operational elements discussed above.

4.3.2 Recommendations

R.5 That an assumed use template is agreed on and implemented for the 2022-23 water year. In lieu of an assumed use template, the PPM Working Group could agree and progress an alternative process that documents the necessary data, methods and assumptions in a fit for purpose approach for implementation as soon as possible.

R.6 That WNSW, DPE-E&HG and DPE-Water collaborate to streamline the PPM process including fit-for-purpose water ordering that specifies the assumed use method/accounting methods to be adopted, access licence splits and contingency

budgets. Documentation of risk identification, assessment and consideration should be included, including continency arrangements for stochastic events (e.g. local rainfall, system surpluses). This work will help progress recommendation R.4 from the 2019-20 review.

4.4 Proposals for new actions using PPMs

Several new or altered environmental watering actions using PPMs were proposed during the previous water year (2019-20 and documented in the annual evaluation and review report for the same year). A status update on the implementation of these actions during 2020-21 is provided in Table 4.

Table 4: Progress on the implementation of new actions using PPMs proposed during 2019-20

River system	Proposed action	Status (February 2022)
Lower Darling	Return flows into the River Murray when MLS is under NSW control	Return flows recognised for one event only (May-June 2021) HEW delivered on top of other flows (December 2020-Januray 2021) NSW to develop a policy on PPMs from Menindee Lakes System when under NSW control (see R.1) Documented in this review (section 4.1.1)
Murray	Edward/Kolety Wakool River System • accounting treatment as per 2019-20	Seasonal loss treatment approach applied Documented in this review (section 4.1.1)
Murray	Werai Forest • accounting treatment for directed releases from Hume resulting in overbank flows • accounting treatment for environmental return flows from the forest	Accounting treatment is currently being considered – initial background work has commenced.
Murrumbidgee	Accounting for return flows from Murrumbidgee into River Murray (Balranald to SA border)	Return flows recognised Incremental losses applied Documented in this review (section 4.1.1)
Murrumbidgee	Lowbidgee weir pool filling • accounting treatment for environmental return flows	Given low priority on the work plan by the PPM Working Group
Murrumbidgee	Mid-Murrumbidgee wetlands • accounting treatment for environmental return flows from these wetlands to Balranald	Assumed use and accounting treatment yet to be progressed

River system	Proposed action	Status (February 2022)
Murrumbidgee	Beavers Creek/Old Man Creek anabranch • Mid-Murrumbidgee wetlands reconnection action • native fish action	Given low priority on the work plan by the PPM Working Group

New watering environmental watering actions using PPMs proposed by environmental water holders for the 2020-21 water year are listed in Table 5. These actions were raised by the environmental water holders and added to the work plan throughout the water year. The work plan was regularly reviewed by agencies and tasks prioritised for resourcing purposes. The actions listed below were all given high priority on the work plan by the PPM Working Group.

Table 5: New environmental watering actions using PPMs proposed in 2020-21

River system	Proposed action	Status (February 2022)
Murray (Edward Kolety- Wakool)	Implement return flow accounting arrangements through Murray Irrigation Limited (MIL) 'accredited' escapes (Wakool, Edward, Niemur, Finley/Billabong and Perricoota escapes).	Use of MIL escapes for environmental water deliveries using PPMs is included on the PPM work plan.
Murrumbidgee	Mid-Murrumbidgee wetlands reconnection. Investigate assumed use and accounting treatment/s for environmental return flows from wetlands to Balranald (autumn/winter 2022).	Assumed use and accounting treatment to be progressed as a high priority for the next water year.
Murrumbidgee	Yanco/Billabong/Forest Creek system. Investigate accounting treatment for in-channel deliveries and possible return flows into the River Murray (including possible incremental loss application) (November 2021)	Initially modelling work has been undertaken.
Murray	Werai Forest. Investigate assumed use and accounting treatment for spring flows (spring 2022).	Some initial background work has commenced.

4.4.1 Findings

Table 5 provides a status update on each of the proposed new actions. All of these proposed actions are included on the work plan.

Historically, the Commonwealth has delivered environmental water via Murray Irrigation Limited (MIL) escapes as a way to either assist in the dilution of poor water quality events (such as a hypoxic blackwater event), or to add to in-river flows to meet environmental flow targets. The environmental water holders pay a 17% conveyance loss to MIL on all orders delivered via the escapes. In July 2020, the CEWH initiated a proposal requesting the

recognition of return flows for environmental water delivered through MIL escapes. The proposal was considered by the department and river operators. An interagency meeting was held to advise that NSW was not able to deliver a PPM event (recognising return flows) through the MIL escapes for the 2020-21 water year. There are a number of implementation (and policy) issues around the proposal that need to be resolved.

4.4.2 Recommendations

R.7 That the use of MIL escapes for return flows be retained on the work plan and its priority reassessed considering the increased use of escape flows by environmental water holders in 2021-22. NSW to progress internal discussions around possible policy and implementation issues regarding the use of MIL escapes for the delivery of environmental water and the recognition of return flows[26].

4.5 Stakeholder & agency consultation

The procedures manuals identify the importance of consultation during PPM implementation and the annual review. Section 3.3 of the procedures manuals list the minimum consultation requirements associated with the operation of the trial and agreed actions within NSW.

4.5.1 Findings

Consultation is an important element in the planning and delivery of environmental water that relies on trial or agreed actions via PPMs, as it provides transparency regarding the decision making process, operation of the actions and the performance of any mitigation measures. As discussed in section 4 of this report, there was ongoing consultation and collaboration between the department, environmental water holders and the river operators in the planning of the Murrumbidgee and Lower Darling releases, the development of the incremental loss approach and the consideration of new proposals put forward.

As part of their (PPM) Annual Environmental Releases River Operations Report, WaterNSW reported consultation was undertaken with both the Lower Darling and Murrumbidgee river operations stakeholder consultation committees (ROSCCos). No PPM specific stakeholder requests were identified in the annual reports provided by WaterNSW. ROSCCo presentations and meeting notes are available on the WaterNSW website.

DPE-E&HG consulted WaterNSW regarding proposed environmental watering actions before placing water orders. In their (PPM) Annual Environmental Watering Statement, DPE-E&HG also reported consultation with the Murray and Lower Darling EWAG in May and June 2020 with no stakeholder requests reported. The Murrumbidgee EWAG and TAG sub-group were also consulted in October 2020 regarding the fish pulse events. No specific issues or requests were reported.

[26] Note that the use of MIL escapes was identified as having moderate priority in the work plan during 2020-21, with the due date nominated as June 2022.

The department participated in forums where the Lower Darling return flows proposal was discussed, including the Lower Darling ROSCCo (chaired by WaterNSW). Stakeholders were concerned about how environmental water releases would affect storage levels in the MLS and capacity to mitigate cease-to-flow conditions in the Lower Darling if there was a prolonged dry period. They also provided comment on their expectations for how The Living Murray (TLM) licence should be used. Although this is a separate issue to the implementation of PPMs, their comments were taken into consideration during the department and State response to the PPM request for recognition of return flows from the Lower Darling in the Murray.

No consultation by the department was undertaken with licensed water users or their representative groups regarding the new loss accounting treatment for return flows from the Murrumbidgee; however, this material will be published on the DPE Environmental Water Hub.

The department consulted with WaterNSW, DPE-E&HG, MDBA and CEWO as part of this annual review process. As no compliance issues relating to the PPM watering actions were raised or reported, the Natural Resources Access Regulator (NRAR) was not consulted during this annual review process.

The PPM Working Group (chaired by DPE-Water) has representatives from DPE-E&HG, WaterNSW, CEWO and MDBA. The Group met twice formally (November 2020 and March 2021). A number of out-of-session emails were exchanged and teleconferences were also held.

The 2019-20 annual review highlighted the need for further clarification of the consultation responsibilities of respective agencies with regards to PPMs, particularly around annual reporting. The provision of more detail of the extent and results of consultation in the agency's annual PPM reports would be helpful.

4.5.2 Recommendations

R.8 Review and update the consultation requirements outlined in the procedures manuals to clarify agency responsibilities and stakeholder expectations. Update the templates for the Annual Environmental Release River Operations Report and Annual Environmental Watering Statement as necessary to reflect these changes.

4.6 Implementation of recommendations from 2019-20 annual review

Adaptive management is one of the key principles underpinning PPM implementation in NSW. The commitment to adaptive management is recognition that the environmental watering actions provided by PPMs are different to previous regulated river system operations and will require ongoing development over time.

Each annual review is an opportunity to analyse and review PPM operations and processes, and to reconsider previous review recommendations against the new ones. The annual review is a key component of the NSW Government's commitment to the ongoing implementation of PPMs, including the implementation of improvements from previous reviews.

4.6.1 Findings

PPMs took effect on 1 July 2019. The first annual evaluation and review report of the implementation of PPMs in NSW (for the 2019-20 water year) identified ten recommendations. The status of each of these recommendations is provided in Table 6.

Table 6: Status of recommendations made in the 2019-20 PPM annual evaluation and review report

2019-20 Recommendation		Status (February 2022)
R.1	Include clear advice in procedures manuals on how to evaluate whether PPM actions provide for the efficient and effective use of HEW.	See recommendation R.1 of this report.
R.2	Review the Edward Kolety-Wakool seasonal loss accounting treatment.	See recommendation R.3 of this report.
R.3	Agencies to adhere to the agreed roles and responsibilities as set out in the procedures manuals.	A draft PPM process chart was provided to the PPM Working Group at meeting #6 in October 2021. See recommendation R.5 and R.6 of this report.
R.4	Review and streamline PPMs environmental watering actions record-keeping, data management and information exchange between agencies.	A draft PPM process chart was provided to the PPM Working Group at meeting #6 in October 2021. See recommendation R.5 and R.6 of this report.
R.5	Adoption of Aboriginal dual place names for PPMs environmental watering actions, communication and reporting.	Adopted for this report to align with the DPE Aboriginal Dual Names Policy.
R.6	Annual Environmental Releases River Operations Report to include information about identified risks and mitigation measures.	Annual Environmental Releases River Operations Report was not updated to specifically include risk and mitigation measures. See recommendations R.4 and R.5 of this report.
R.7	Clarify agency consultation requirements.	Carried forward. See recommendation R.10 of this report.
R.8	Agencies to adopt consistent PPMs actions naming, numbers, volumes, etc.	In progress. See recommendation R.5 of this report.

2019-20 Recommendation		Status (February 2022)
R.9	Provide Assumed Use Statements where accurate measurement is not possible.	In progress. See recommendation R.5 of this report.
R.10	Clearly communicate in a timely manner the details of each new and ongoing PPMs environmental watering action and supporting measures.	In progress. See recommendation R.5 of this report.

4.6.2 Recommendations

R.9 Update the NSW PPM work plan once the annual review has been approved to add new recommendations from this report. The recommendations from the annual review should then be prioritised in light of other high priority work for PPMs as determined by the PPM Work Group.

R.10 DPE-Water to progress a review of the procedures manuals and update as necessary to reflect new actions and the outcomes of recommendations made based on the two annual reviews completed to date. This should include any changes to process and consultation requirements.

Appendix A WaterNSW Annual Environmental Release River Operations Report

WaterNSW provided the following Annual Environmental Release River Operations Reports to the department. It forms part of this annual review.

Lower Darling-Baaka River fish flows (LOD20/21-01)

1. ENVIRONMENTAL WATERING ACTIONS

In Table 1, provide an overview of the environmental water actions undertaken using PPMs in the 2020-21 water year.

Table 1: Summary of PPM watering actions in 2020-21

Name of environmental watering action	LOD20/21-01 [Event #1] Fish Flows
River system	Lower Darling/Baaka River
Type of PPM event	Return Flow Recognition in the River Murray (not recognised, as per decision made by NSW) Environmental water delivered on top of other flows
General description of watering action	Elevated based flows and small fresh to provide increased habitat and suitable conditions for breeding and recruitment.
Start date	15 September 2020
End date	17 January 2021
Was this an agreed or interim action?	Interim
Delivery pathway	Lower Darling channel (Weir 32 to Burtundy)

Name of environmental watering action	LOD20/21-01 [Event #1] Fish Flows
Environmental site/s watered	Lower Darling/Baaka River channel
Total volume of water delivered (ML)	24,852 ML
Accounting method used	Determination of use by the difference between releases without e-water (the operational requirement) and with delivery of the e-water hydrograph.

2. WATER ORDERS

In Table 2, provide an overview of the environmental water orders received for Prerequisite Policy Measures in the 2020-21 water year (including any order that was subsequently refused/rejected).

Provide further details in an as needed, including water orders and assumed use statements. If any water order using PPMs was refused, please provide documentation and rationale supporting this decision.

Table 2: Water orders received by WaterNSW in 2020-21

Order number	1	2	3	4	5
Organisation submitting order	DPE-E&HG	DPE-E&HG	DPE-E&HG	DPE-E&HG	DPE-E&HG
Date order was submitted	11 September 2020	27 October 2020	20 November 2020	25 November 2020	1 December 2020
Volume of order (ML)	9,200	1,700	1,357	14,760	1,387
Organisation delivering order					
Release date	15 September – 30 October 2020	31 October – 15 November 2020	16 November – 29 November 2020	27 November 2020 – 15 January 2021	25 November – 27 November 2020

Order number	1	2	3	4	5
Form of water order submitted (e.g. Form A, email, verbal, other)	Email	Email	Email	Email	Email
List of supporting documents					

3. COMPARISON OF FORECAST AND ACTUAL ENVIRONMENTAL WATER USE

Provide an overview of:

- target daily flow rates and volumes
  — See Charts 1 and 2
- actual daily flow rates and volumes
  — See Charts 1 and 2
- forecast losses and actual losses (at an appropriate temporal scale for the event)
  — Not applicable to this event
- volume of environmental water debited (with licence corresponding licence numbers)

WAL	Sum of Orders (ML)	Sum of Usage (ML)
60AL582512	14760	13665
60AL583376	13344	11187
Grand Total	**28104**	**24852**


Target E-water Hydrograph v Actual Stream Discharge at Weir 32
E-water Target Hydrograph
Actual Flow
Stream Discharge (ML/day)
1800
1600
1400
1200
1000
800
600
400
200
0
16-Sep-20
23-Sep-20
30-Sep-20
07-Oct-20
14-Oct-20
21-Oct-20
28-Oct-20
04-Nov-20
11-Nov-20
18-Nov-20
25-Nov-20
02-Dec-20
09-Dec-20
16-Dec-20
23-Dec-20
30-Dec-20
06-Jan-21
13-Jan-21


Daily E-water Order v Daily Debit
E-Water Order
E-water Debit
Volume (ML)
1400
1200
1000
800
600
400
200
0
16-Sep-20
23-Sep-20
30-Sep-20
07-Oct-20
14-Oct-20
21-Oct-20
28-Oct-20
04-Nov-20
11-Nov-20
18-Nov-20
25-Nov-20
02-Dec-20
09-Dec-20
16-Dec-20
23-Dec-20
30-Dec-20
06-Jan-21
13-Jan-21

4. STAKEHOLDER CONSULTATION

In Table 3, provide a summary of stakeholder consultation. Attach any supporting documents.

Table 3: Summary of stakeholder consultation

Date	Stakeholder forum/name	Environmental watering action/s discussed	Type of consultation	Summary of feedback	Stakeholder requests	List of supporting documents
Continuous	Lower Darling ROSCCo	Forum provides opportunity for community and customer engagement on operational matters including discussion of e-water delivery and potential resource implications	Video conference			

5. RECOMMENDATIONS TO IMPROVE FUTURE ENVIRONMENTAL WATERING ACTIONS

In Table 4, provide a summary of key issues encountered in 2020-21 and recommendations for addressing these. Attach any supporting documents.

Table 4: Summary of issues and recommendations

Environmental watering action	Issue	Agencies involved	Stakeholders involved	Recommendations	List of supporting documents
Event #1	Water order and debit reconciliation. Debit did not meet the expectations of the customers and following close of billing amendments were requested consuming significant time and resources to understand the issue and seek correction	DPE-E&HG, CEWO & TLM			

Attachment A – Water orders

Attachment B – Assumed Use Statements and evidence of other calculations used

Attachment C – Details of stakeholder consultation and feedback

Attachment D – Supporting documents for key issues encountered and recommendations to address these

Lower Darling-Baaka River autumn - winter flows (LOD20/21-02)

1. ENVIRONMENTAL WATERING ACTIONS

In Table 1, provide an overview of the environmental water actions undertaken using PPMs in the 2020-21 water year.

Table 1: Summary of PPM watering actions in 2020-21

Name of environmental watering action	LOD20/21-02 [Event #2] Autumn – Winter Flows
River system	Lower Darling/Baaka River
Type of PPM event	Return Flow Recognition in the River Murray Environmental water delivered on top of other flows
General description of watering action	Elevated based flows to provide increased habitat for the recovering native fish community
Start date	1 May 2021
End date	30 June 2021
Was this an agreed or interim action?	Interim
Delivery pathway	Lower Darling channel (Weir 32 to Burtundy)
Environmental site/s watered	Lower Darling/Baaka River channel
Total volume of water delivered (ML)	7,443 ML
Accounting method used	Determination of use by the difference between releases without e-water (the operational requirement) and with delivery of the e-water hydrograph

2. WATER ORDERS

In Table 2, provide an overview of the environmental water orders received for Prerequisite Policy Measures in the 2020-21 water year (including any order that was subsequently refused/rejected).

Provide any further details in an as needed, including water orders and assumed use statements. If any water order using PPMs was refused, please provide documentation and rationale supporting this decision.

Table 2: Water orders received by WaterNSW in 2020-21

Order number	1	2	3 (Amendment of order 1)	4 (Amendment of order 2)	5 (Amendment of order 4)
Organisation submitting order	DPE-E&HG	DPE-E&HG	DPE-E&HG	DPE-E&HG	DPE-E&HG
Date order was submitted	29 April 2021	29 April 2021	20 June 2021	25 June 2021	29 June 2021
Volume of order (ML)	11500	4860	7,020	837	648
Organisation delivering order					
Release date	1 May – 24 June 2021	1 May – 23 June 2021	1 May – 24 June 2021	1 May – 23 June 2021	1 May – 23 June 2021
Form of water order submitted (e.g. Form A, email, verbal, other)	Email	Email	Email	Email	Email
List of supporting documents					

3. COMPARISON OF FORECAST AND ACTUAL ENVIRONMENTAL WATER USE

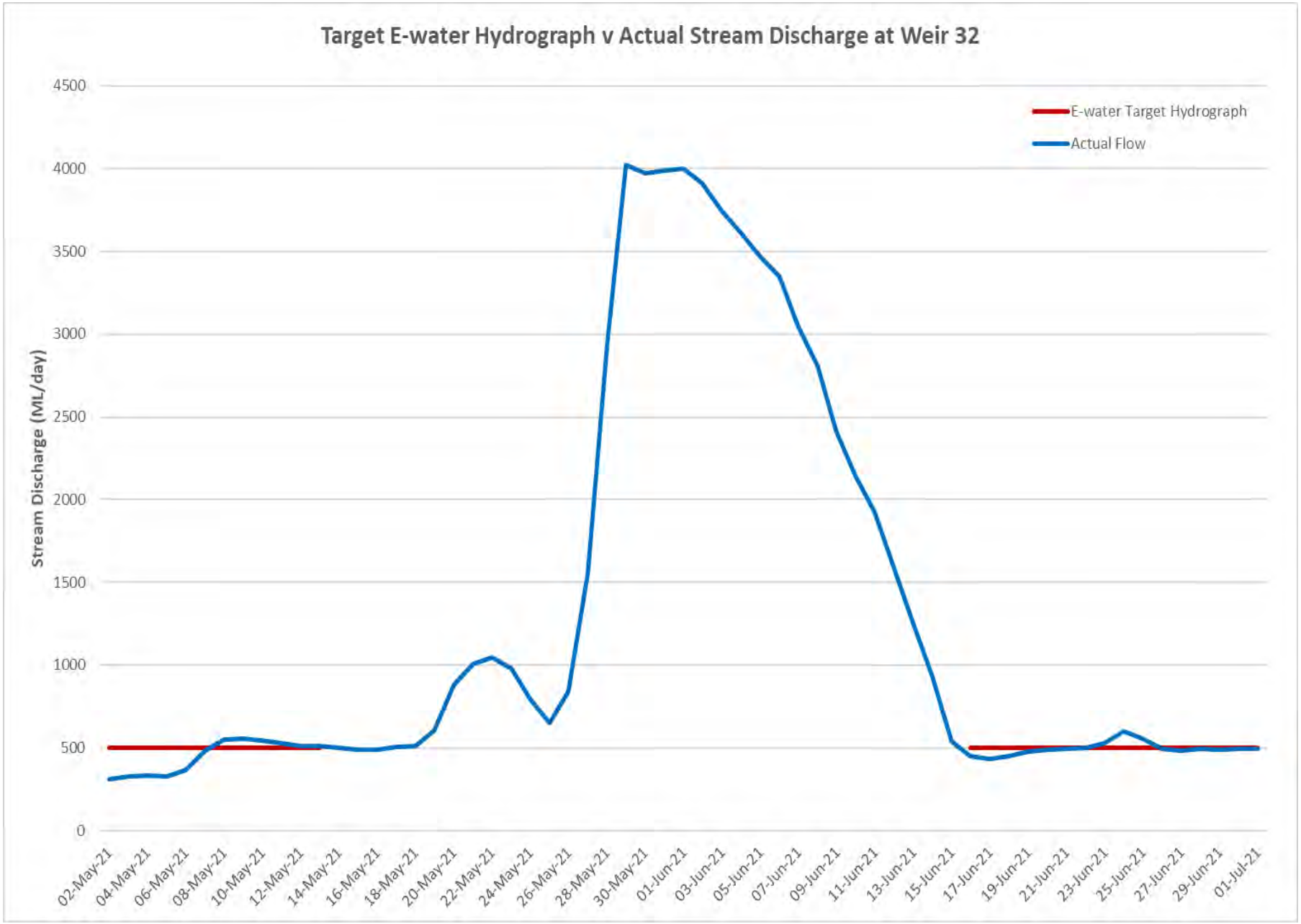
Provide an overview of:

- target daily flow rates and volumes
  - See Charts 1 and 2
- actual daily flow rates and volumes
  - See Charts 1 and 2
- forecast losses and actual losses (at an appropriate temporal scale for the event)
  - The loss table provided by DPE-Water was used to assess the loss rates for the event. These were calculated to 6% for the duration of the event. The actual total loss for the duration of the event averaged 9%.
- volume of environmental water debited (with licence corresponding licence numbers)

WAL	Sum of Orders	Sum of Usage
60AL582512	6435	6795
60AL583376	648	648
Grand Total	**7083**	**7443**

- volume of water delivered to the Murray Valley that will be recognised as environmental water – 5,610 ML after the application of assumed loss.

Attach any supporting information.


Target E-water Hydrograph v Actual Stream Discharge at Weir 32
Stream Discharge (ML/day)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
E-water Target Hydrograph
Actual Flow
02-May-21
04-May-21
06-May-21
08-May-21
10-May-21
12-May-21
14-May-21
16-May-21
18-May-21
20-May-21
22-May-21
24-May-21
26-May-21
28-May-21
30-May-21
01-Jun-21
03-Jun-21
05-Jun-21
07-Jun-21
09-Jun-21
11-Jun-21
13-Jun-21
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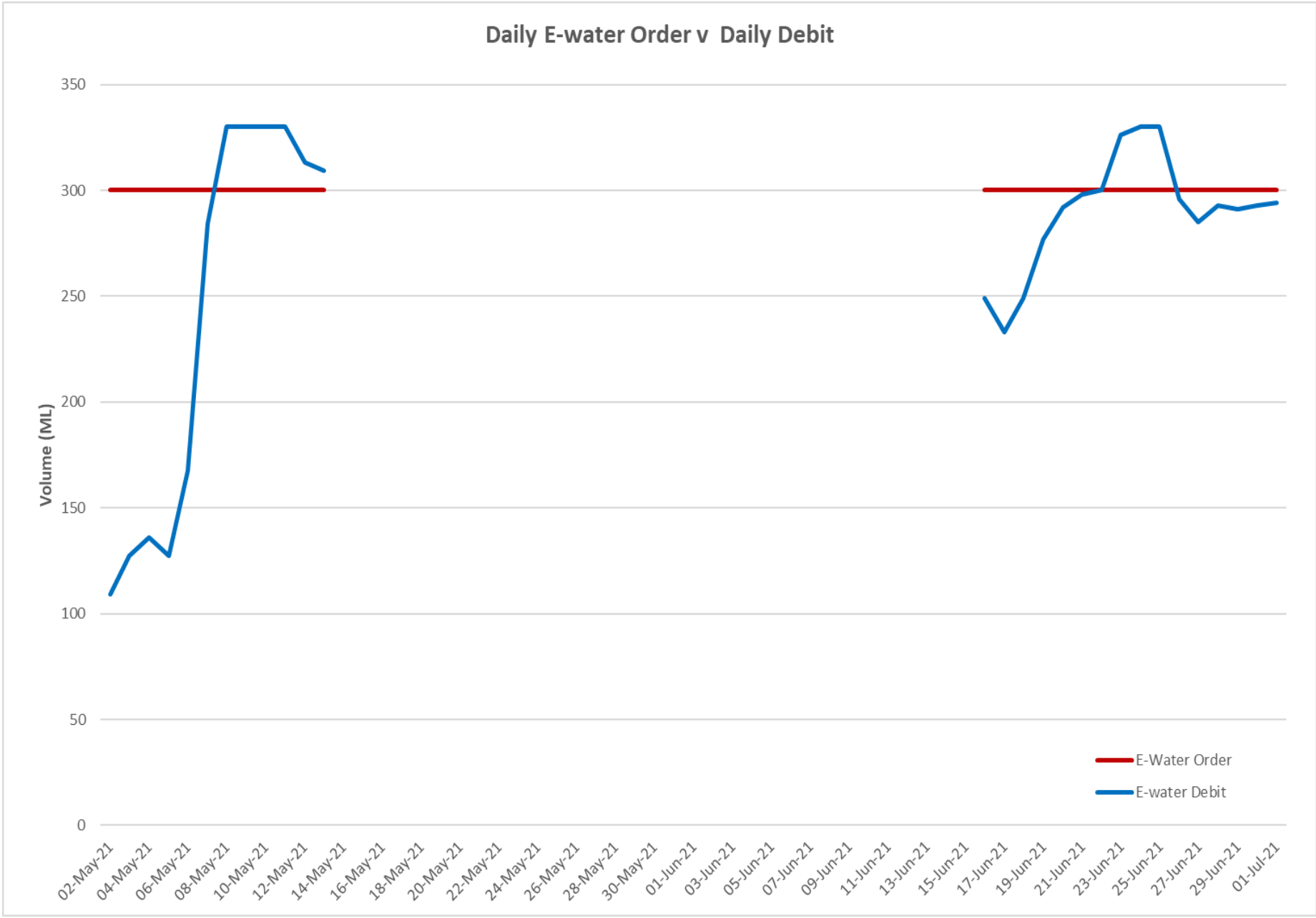
29-Jun-21
01-Jul-21


Daily E-water Order v Daily Debit
Volume (ML)
350
300
250
200
150
100
50
0
02-May-21
04-May-21
06-May-21
08-May-21
10-May-21
12-May-21
14-May-21
16-May-21
18-May-21
20-May-21
22-May-21
24-May-21
26-May-21
28-May-21
30-May-21
01-Jun-21
03-Jun-21
05-Jun-21
07-Jun-21
09-Jun-21
11-Jun-21
13-Jun-21
15-Jun-21
17-Jun-21
19-Jun-21
21-Jun-21
23-Jun-21
25-Jun-21
27-Jun-21
29-Jun-21
01-Jul-21
E-Water Order
E-water Debit

4. STAKEHOLDER CONSULTATION

In Table 3, provide a summary of stakeholder consultation. Attach any supporting documents.

Table 3: Summary of stakeholder consultation

Date	Stakeholder forum/name	Environmental watering action/s discussed	Type of consultation	Summary of feedback	Stakeholder requests	List of supporting documents
Continuous	Lower Darling ROSCCo	Forum provides opportunity for community and customer engagement on operational matters including discussion of e-water delivery and potential resource implications	Video conference			

5. RECOMMENDATIONS TO IMPROVE FUTURE ENVIRONMENTAL WATERING ACTIONS

In Table 4, provide a summary of key issues encountered in 2020-21 and recommendations for addressing these. Attach any supporting documents.

Table 4: Summary of issues and recommendations

Environmental watering action	Issue	Agencies involved	Stakeholders involved	Recommendations	List of supporting documents
Event #1 (LOD20/21-01)	Water order and debit reconciliation. Debit did not meet the expectations of the customers and following close of billing amendments were requested consuming significant time a resource to understand the issue and seek correction	DPE-E&HG, CEWO & TLM			

Attachment A – Water orders

Attachment B – Assumed Use Statements and evidence of other calculations used

Attachment C – Details of stakeholder consultation and feedback

Attachment D – Supporting documents for key issues encountered and recommendations to address these

Murrumbidgee native fish pulses (November 2020 and May 2021) (MBG20/21-11)

1. ENVIRONMENTAL WATERING ACTIONS

In Table 1, provide an overview of the environmental water actions undertaken using PPMs in the 2020-21 water year.

Table 1: Summary of PPM watering actions in 2020-21

Name of environmental watering action	Native Fish Pulse-1 (November 2020)	Native Fish Pulse-2 (May 2020)
River system	Murrumbidgee River	Murrumbidgee River
Type of PPM event	Return Flow Recognition from Tributary Inflows	Return Flow Recognition from Tributary Inflows
General description of watering action	Moderate in-channel pulse targeting native fish movement and recruitment, productivity and instream vegetation	Moderate in-channel pulse targeting native fish movement and recruitment, productivity and instream vegetation
Start date	9 Nov 2020	9 May 2021
End date	18 Nov 2020	29 May 2021
Was this an agreed or interim action?	Interim	Interim
Delivery pathway	Headworks storages to Murray River	Headworks storages to Murray River
Environmental site/s watered	Murrumbidgee River downstream of Balranald Weir	Murrumbidgee River downstream of Balranald Weir
Total volume of water delivered (ML)	30,000	32,968

Name of environmental watering action	Native Fish Pulse-1 (November 2020)	Native Fish Pulse-2 (May 2020)
Accounting method used	Determination of use by the difference between releases without e-water (the operational requirement) and with delivery of the e-water hydrograph	Determination of use by the difference between releases without e-water (the operational requirement including IVT) and with delivery of the e-water hydrograph

2. WATER ORDERS

In Table 2, provide an overview of the environmental water orders received for Prerequisite Policy Measures in the 2020-21 water year (including any order that was subsequently refused/rejected).

Provide any further details as needed, including water orders and assumed use statements. If any water order using PPMs was refused, please provide documentation and rationale supporting this decision.

Table 2: Water orders received by WaterNSW in 2020-21

Order number	1a	1b (Extension of order 1)	2a	2b	2c (Amendment of order 2b)
Organisation submitting order	DPE-E&HG	DPE-E&HG	DPE-E&HG	DPE-E&HG	DPE-E&HG
Date order was submitted	28 Oct 2020	30 Oct 2020	20 April 2021	20 April 2021	24 June 2021
Volume of order (ML)	12,000	18,000	30,000	4,902	1,117
Organisation delivering order					
Release date	9 Nov – 18 Nov 2020	9 Nov – 18 Nov 2020	8 May – 24 May 2021	8 May – 24 May 2021	8 May – 24 May 2021

Order number	1a	1b (Extension of order 1)	2a	2b	2c (Amendment of order 2b)
Form of water order submitted (e.g. Form A, email, verbal, other)	Email	Email	Email	Email	Email
List of supporting documents					

3. COMPARISON OF FORECAST AND ACTUAL ENVIRONMENTAL WATER USE

Provide an overview of:

- target daily flow rates and volumes
  - See Charts 1 and 3
- actual daily flow rates and volumes
  - See Charts 2 and 4
  - The actual flow is daily average operational flow data for GS 410130 Murrumbidgee River downstream of Balranald Weir (Source: Hydstra)
  - The operational required flow without e-water pulse is calculated as a sum of
    - Planned Environmental Water -1 (PEW-1) i.e. the daily minimum flow required at Balranald (Source: Murrumbidgee Work Approval and Water Accounting System of WaterNSW)
    - Water orders by irrigators below the Balranald Weir (Source: Water Accounting System of WaterNSW)
    - IVT water orders agreed between RMO and WaterNSW operations (if any) (Source: Emails between RMO and WaterNSW; and Water Accounting System of WaterNSW)
    - The e-water target flow rates are determined as the difference between actual flow and the operational required flow.
- forecast losses and actual losses (at an appropriate temporal scale for the event)
  - As the e-Water target flow was referenced at the end of system, the losses within the channel were socialised. However, the additional system loss of 3,049 ML incurred below Redbank Weir (due to the opening of Yanga Creek regulator and Tala Escape)

were made good by placement of additional orders (post event). The additional water orders were reconciled based on flow measurements provided by E&H.

- volume of environmental water debited (with licence corresponding licence numbers) during November 2020 and May 2021:

WAL	Event	Sum of Orders	Sum of Usage
40AL405811	Nov-20	30,000	30,000
40AL405811	May-21	30,000	30,000
40AL415740	May-21	6,017	2,968
Grand Total		**66,017**	**62,968**

- volume of water delivered to the Murray Valley that will be recognised as environmental water after the application of loss calculated using the loss table provided by DPE-Water:
  - 29,188 ML during the event in November 2020
  - 30,398 ML during the event in May 2021.

Attach any supporting information.

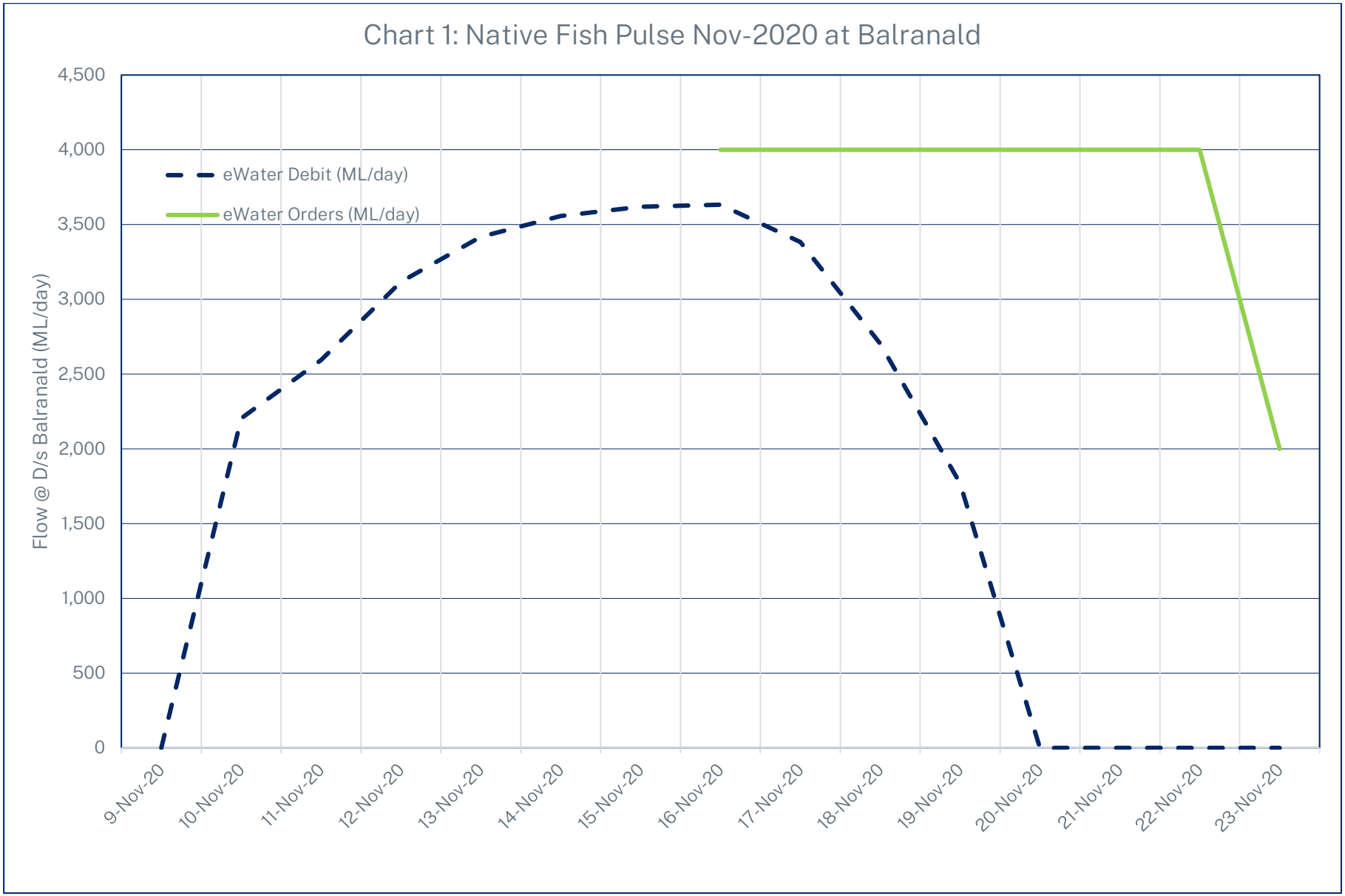


Chart 1: Native Fish Pulse Nov-2020 at Balranald
Flow @ D/s Balranald (ML/day)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
eWater Debit (ML/day)
eWater Orders (ML/day)
9-Nov-20
10-Nov-20
11-Nov-20
12-Nov-20
13-Nov-20
14-Nov-20
15-Nov-20
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18-Nov-20
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21-Nov-20
22-Nov-20
23-Nov-20

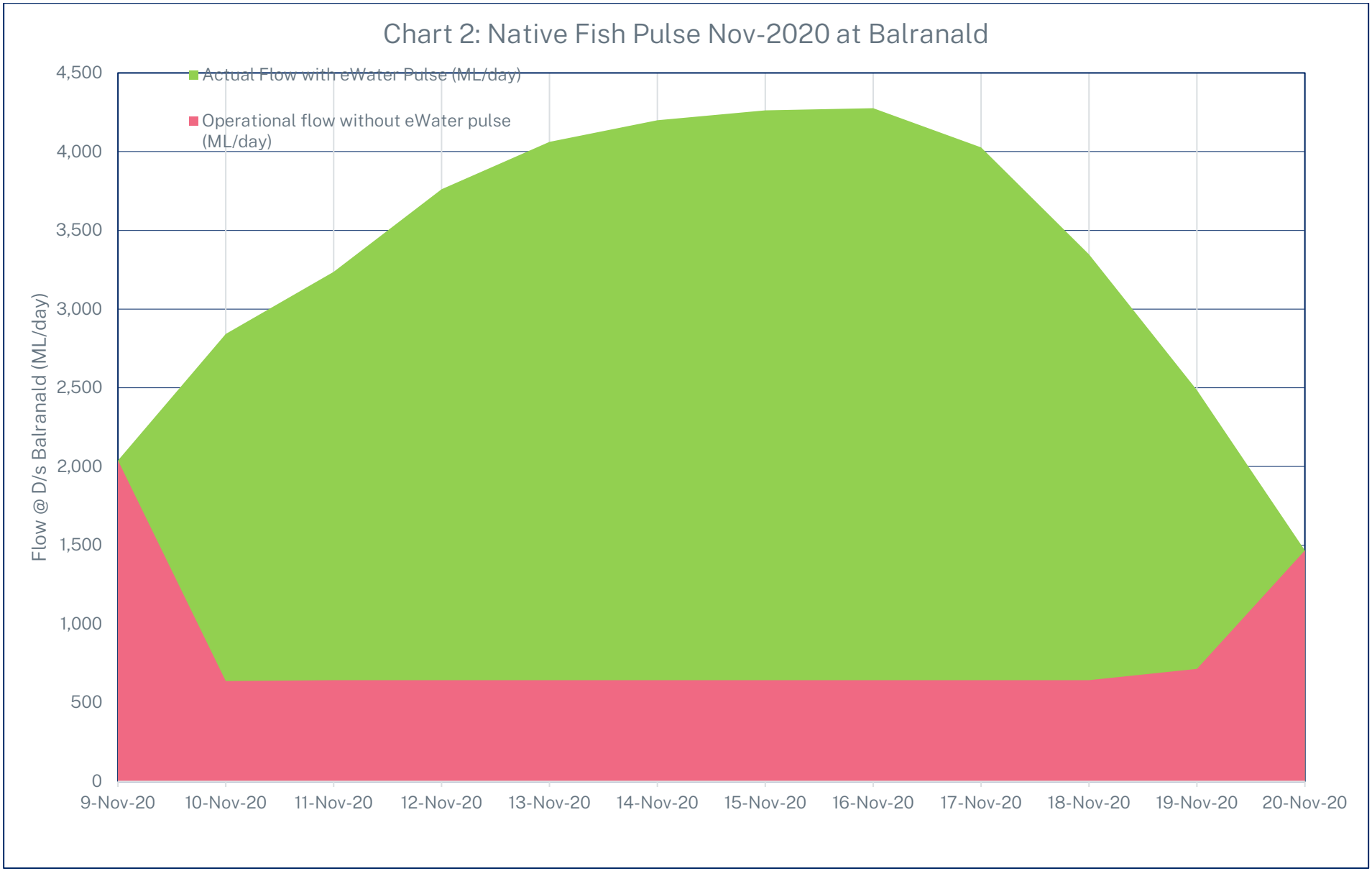
Chart 2: Native Fish Pulse Nov-2020 at Balranald
Actual Flow with eWater Pulse (ML/day)
Operational flow without eWater pulse (ML/day)
Flow @ D/s Balranald (ML/day)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
9-Nov-20
10-Nov-20
11-Nov-20
12-Nov-20
13-Nov-20
14-Nov-20
15-Nov-20
16-Nov-20
17-Nov-20
18-Nov-20
19-Nov-20
20-Nov-20

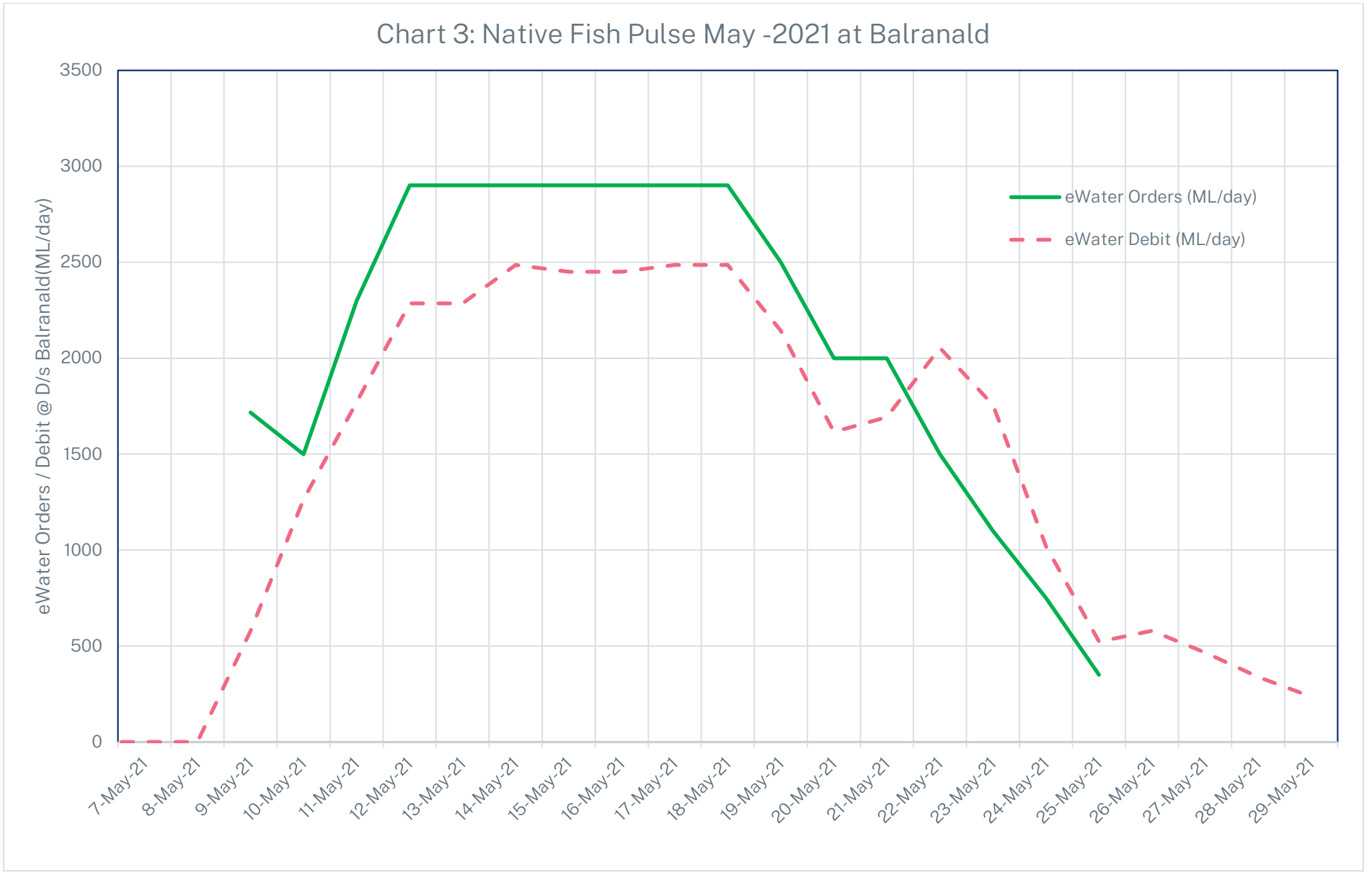
Chart 3: Native Fish Pulse May -2021 at Balranald
eWater Orders / Debit @ D/s Balranald(ML/day)
3500
3000
2500
2000
1500
1000
500
0
eWater Orders (ML/day)
eWater Debit (ML/day)
7-May-21
8-May-21
9-May-21
10-May-21
11-May-21
12-May-21
13-May-21
14-May-21
15-May-21
16-May-21
17-May-21
18-May-21
19-May-21
20-May-21
21-May-21
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24-May-21
25-May-21
26-May-21
27-May-21
28-May-21
29-May-21

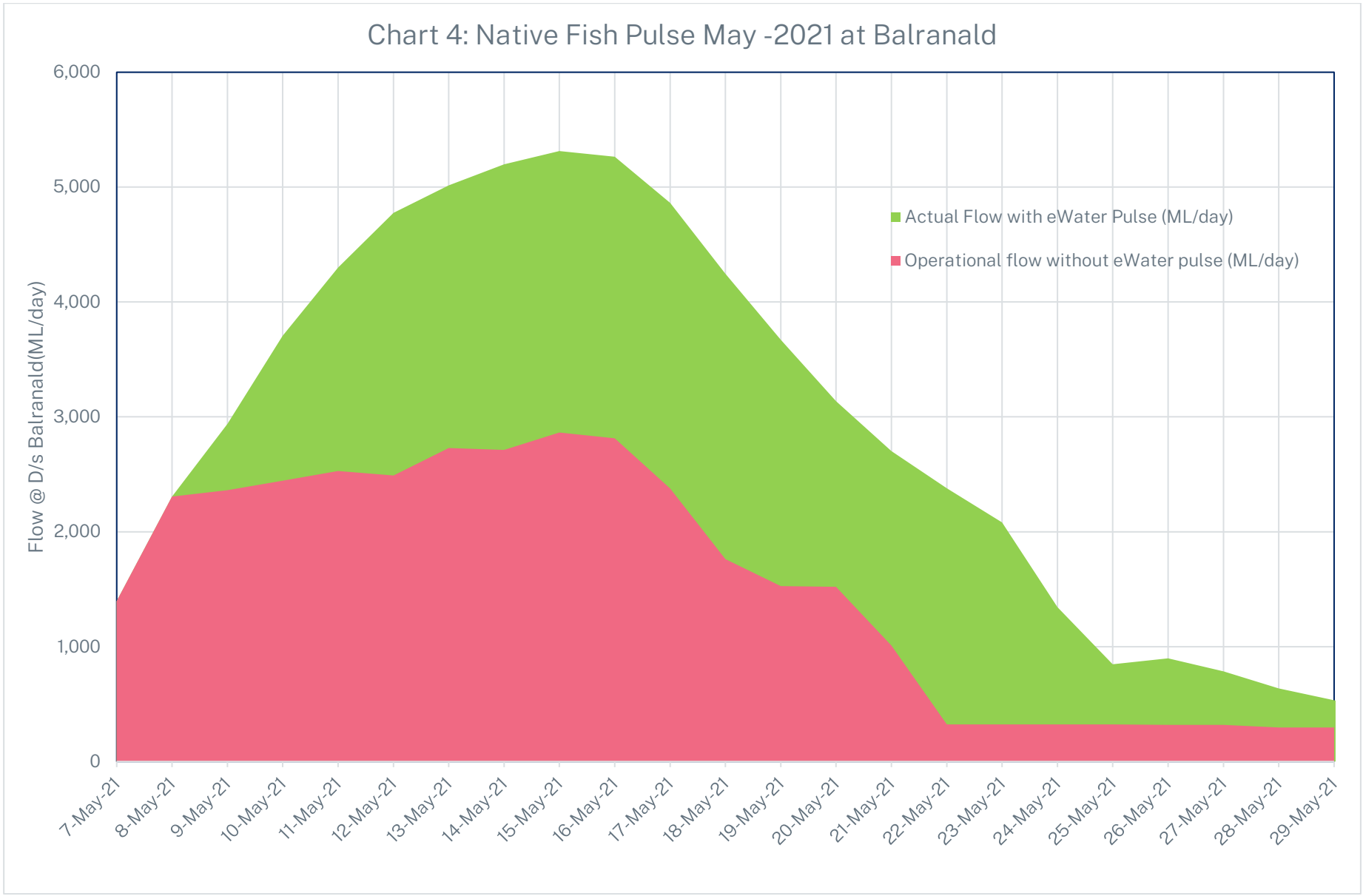


Chart 4: Native Fish Pulse May -2021 at Balranald
Flow @ D/s Balranald(ML/day)
6,000
5,000
4,000
3,000
2,000
1,000
0
Actual Flow with eWater Pulse (ML/day)
Operational flow without eWater pulse (ML/day)
7-May-21
8-May-21
9-May-21
10-May-21
11-May-21
12-May-21
13-May-21
14-May-21
15-May-21
16-May-21
17-May-21
18-May-21
19-May-21
20-May-21
21-May-21
22-May-21
23-May-21
24-May-21
25-May-21
26-May-21
27-May-21
28-May-21
29-May-21

4. STAKEHOLDER CONSULTATION

In Table 3, provide a summary of stakeholder consultation. Attach supporting documents in Attachment C.

Table 3: Summary of stakeholder consultation

Date	Stakeholder forum/name	Environmental watering action/s discussed	Type of consultation	Summary of feedback	Stakeholder requests	List of supporting documents
Continuous	Murrumbidgee ROSCCo	Forum provides opportunity for community and customer engagement on operational matters including discussion of e-water delivery and potential resource implications	Video conference			

5. RECOMMENDATIONS TO IMPROVE FUTURE ENVIRONMENTAL WATERING ACTIONS

In Table 4, provide a summary of key issues encountered in 2020-21 and recommendations for addressing these. Attach any supporting documents.

Table 4: Summary of issues and recommendations

Environmental watering action	Issue	Agencies involved	Stakeholders involved	Recommendations	List of supporting documents
Event #1	Very challenging event for WaterNSW Operations to deliver as supplementary access was happening at the same time	DPE-E&HG, CEWO & TLM			
Event #1	Competing priorities for there were other e-Water events upstream Balranald that interfered with flow peaks at Balranald desired by the environmental customers	DPE-E&HG and CEWO			Emails
Event #2	Unclear accounting methodology as environmental customers did not have a clear plan of apportioning of usage between different licences	DPE-E&HG, CEWO and TLM		A clear watering plan by environmental customer including access licence splits pre-approved during water order process prior to the start of the event.	

Environmental watering action	Issue	Agencies involved	Stakeholders involved	Recommendations	List of supporting documents
Event #2	As this was a piggyback type of event on top of IVT delivery, the daily flow volumes were very subjective. Further, the Tala Escape and Yanga Regulator were open leading to additional losses in the system.	E&H, RMO		A clear watering plan by environmental customer including contingency budget pre-approved with appropriate water order placed in the system prior to the start of the event.	
Event #2	Balranald Weir could not be re-instated as planned at the end of the event due to operational issues and had potential third party impacts e.g. Town Water supply, etc.	E&H and WaterNSW	Balranald Shire	Balranald shire and other water users reliant of the Balranald Weir to be included in the planning of future events	Emails

Attachment A – Water orders

Attachment B – Assumed Use Statements and evidence of other calculations used

Attachment C – Details of stakeholder consultation and feedback

Attachment D – Supporting documents for key issues encountered and recommendations to address these

Edward/Kolety-Wakool River system delivery (MUR20/21-03)

1. ENVIRONMENTAL WATERING ACTIONS

In Table 1, provide an overview of the environmental water actions undertaken using PPMs in the 2020-21 water year.

Table 1: Summary of PPM watering actions in 2020-21

Name of environmental watering action	[Event #5] Edward/Kolety – Wakool River System Fish Flows
River system	NSW Murray
Type of PPM event	Return flows
General description of watering action	Provide flow variability conducive to native fish breeding and recruitment
Start date	21 October 2020
End date	8 May 2021
Was this an agreed or interim action?	Interim
Delivery pathway	Edward–Wakool System
Environmental site/s watered	Edward/Kolety-Wakool River system
Total volume of water delivered (ML)	Total e-water delivered to the site from multi-site and ordered system delivery - 34,663 ML Debit ordered system delivery – 13,278 ML Multi-site delivery – 21,385 ML
Accounting method used	Determination of use by agreed accounting arrangement.

2. WATER ORDERS

In Table 2, provide an overview of the environmental water orders received for Prerequisite Policy Measures in the 2020-21 water year (including any order that was subsequently refused/rejected).

Provide further detail in Attachment A as needed, including water orders and assumed use statements. If any water order using PPMs was refused, please provide documentation and rationale supporting this decision.

Table 2: Water orders received by WaterNSW in 2020-21

Order number	1	2	3	4	5	6	7 (Amendment of 6)	8	9
Organisation submitting order	DPE-E&HG	DPE-E&HG	DPE-E&HG	DPE-E&HG	DPE-E&HG	DPE-E&HG	DPE-E&HG	DPE-E&HG	DPE-E&HG
Date order was submitted	3 Aug 2020	3 Aug 2020	3 Aug 2020	3 Dec 2020	3 Dec 2020	3 Dec 2020	9 Dec 2020	25 Feb 2021	25 Feb 2021
Volume of order (ML)	5,124	976	10,370	3,276	858	4,290	9,009	2,752	3,024
Organisation delivering order									
Release date	3 Aug – 2 Oct 2020	3 Aug – 2 Oct 2020	3 Aug – 2 Oct 2020	13 Dec 2020 – 28 Feb 2021	13 Dec 2020 – 28 Feb 2021	13 Dec 2020 – 11 Jan 2021	13 Dec 2020 – 13 Feb 2021	1 Mar – 25 May 2021	1 Mar – 2 May 2021
Form of water order submitted (e.g. Form A, email, verbal, other)	Email	Email	Email	Email	Email	Email	Email	Email	Email

Order number	1	2	3	4	5	6	7 (Amendment of 6)	8	9
List of supporting documents									

3. COMPARISON OF FORECAST AND ACTUAL ENVIRONMENTAL WATER USE

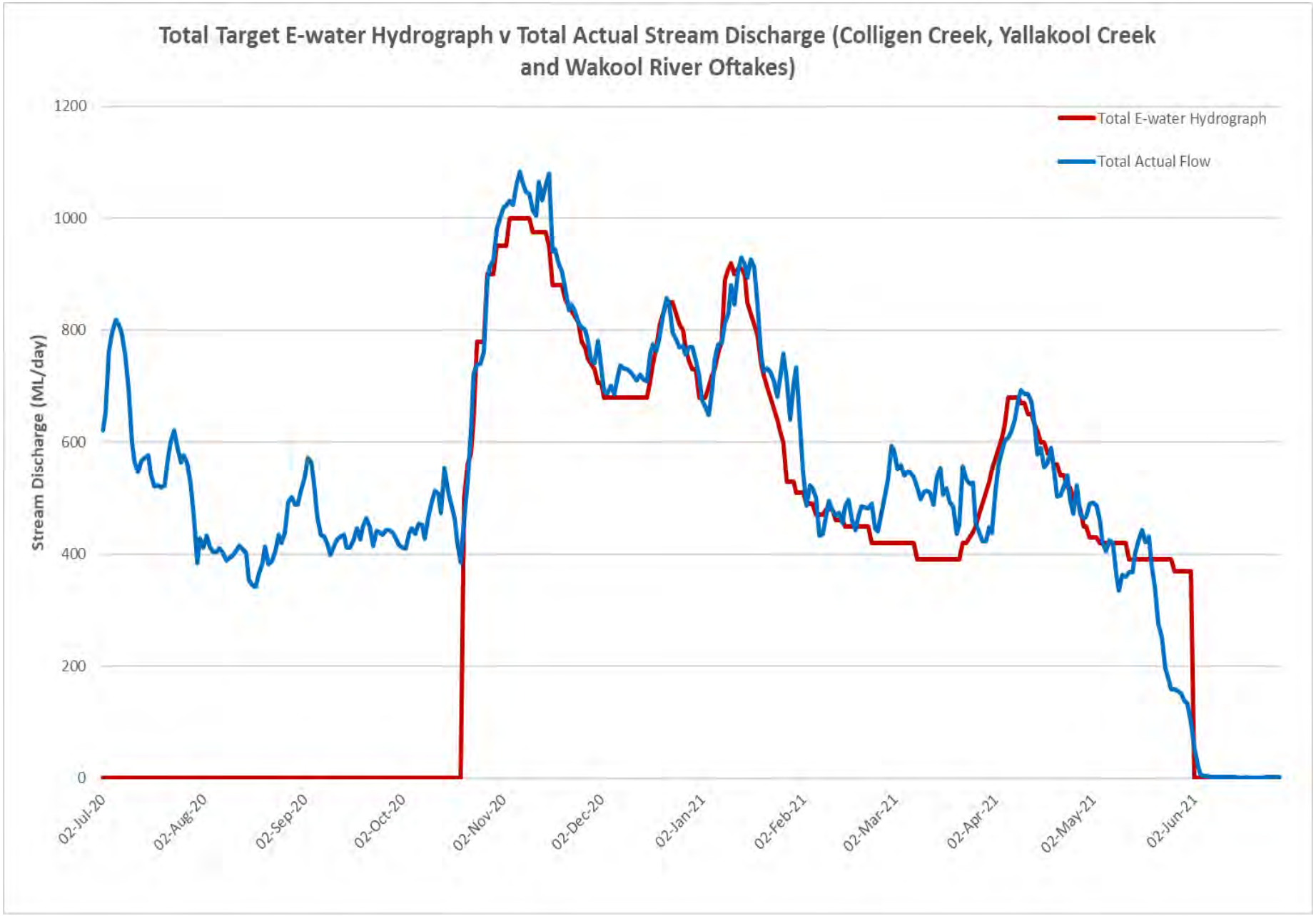
Provide an overview of:

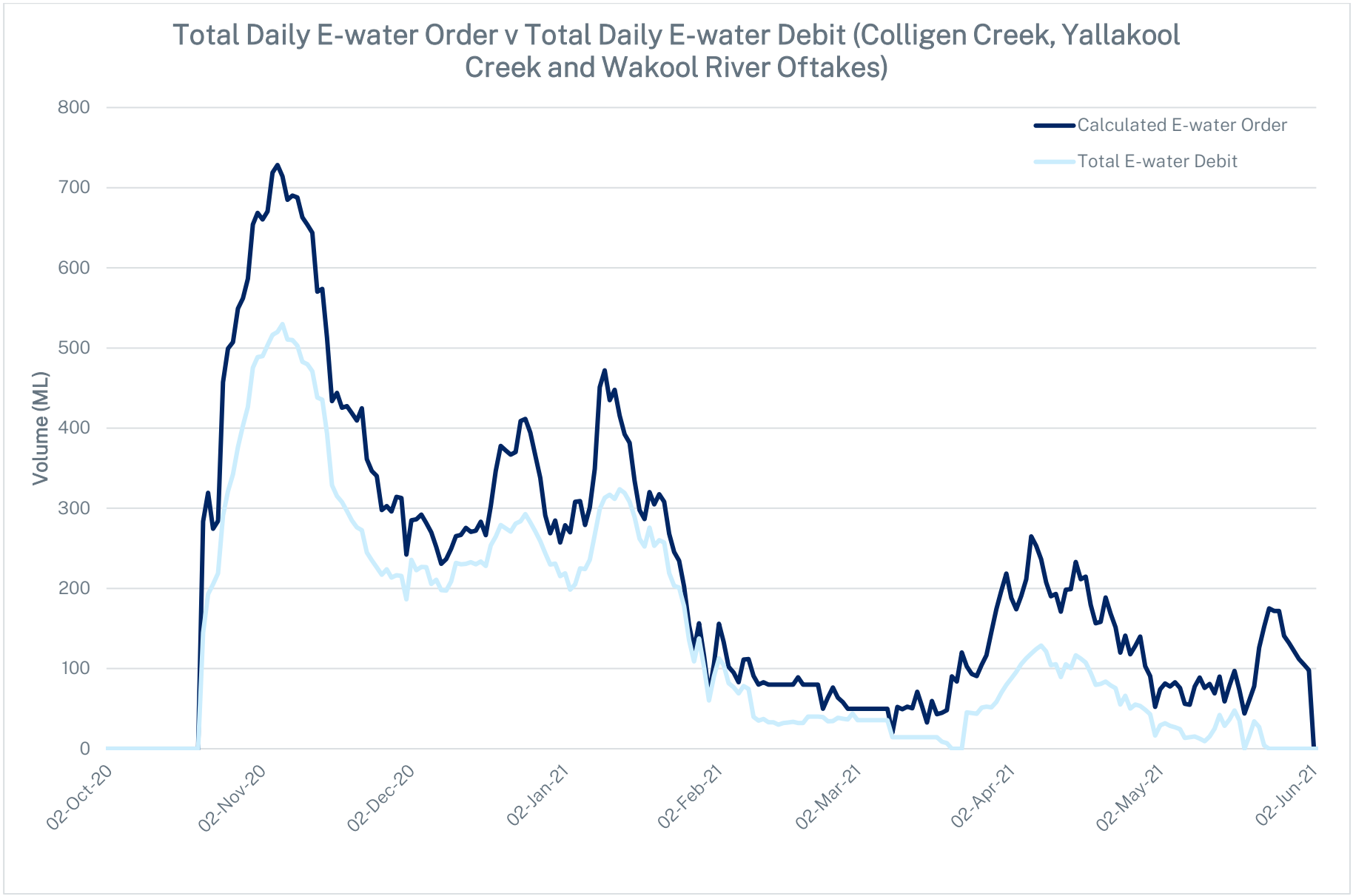
- target daily flow rates and volumes
- See Charts 1 and 2
- actual daily flow rates and volumes
- See Charts 1 and 2
- forecast losses and actual losses (at an appropriate temporal scale for the event)
- Analysis has not been completed.
- volume of environmental water debited (with licence corresponding licence numbers)

WAL	Sum of Orders (ML)	Sum of Usage (ML)
50AL503537	35389	13278
Grand Total	**35389**	**13278**

- volume of water delivered to the Murray Valley that will be recognised as environmental water.
  - All releases for this event were made from Murray storages – as such the debit volume of 13,278 ML is the recognised environmental water volume delivered to the Murray for this event.

Attach any supporting information.


Total Target E-water Hydrograph v Total Actual Stream Discharge (Colligen Creek, Yallakool Creek and Wakool River Oftakes)
Total E-water Hydrograph
Total Actual Flow
Stream Discharge (ML/day)
1200
1000
800
600
400
200
0
02-Jul-20
02-Aug-20
02-Sep-20
02-Oct-20
02-Nov-20
02-Dec-20
02-Jan-21
02-Feb-21
02-Mar-21
02-Apr-21
02-May-21
02-Jun-21


Total Daily E-water Order v Total Daily E-water Debit (Colligen Creek, Yallakool Creek and Wakool River Oftakes)
Calculated E-water Order
Total E-water Debit
Volume (ML)
800
700
600
500
400
300
200
100
0
02-Oct-20
02-Nov-20
02-Dec-20
02-Jan-21
02-Feb-21
02-Mar-21
02-Apr-21
02-May-21
02-Jun-21

4. STAKEHOLDER CONSULTATION

In Table 3, provide a summary of stakeholder consultation. Attach any supporting documents.

Table 3: Summary of stakeholder consultation

Date	Stakeholder forum/name	Environmental watering action/s discussed	Type of consultation	Summary of feedback	Stakeholder requests	List of supporting documents

5. RECOMMENDATIONS TO IMPROVE FUTURE ENVIRONMENTAL WATERING ACTIONS

In Table 4, provide a summary of key issues encountered in 2020-21 and recommendations for addressing these. Attach supporting documents in Attachment D.

Table 4: Summary of issues and recommendations

Environmental watering action	Issue	Agencies involved	Stakeholders involved	Recommendations	List of supporting documents
Event #5	Water order process continues to frustrate all parties with the availability of water for delivery, the timeliness of amendments and the necessary feedback of actual use to the customers so that orders can be managed in real time.	DPE-E&HG, CEWO & TLM			

Attachment A – Water orders

Attachment B – Assumed Use Statements and evidence of other calculations used

Attachment C – Details of stakeholder consultation and feedback

Attachment D – Supporting documents for key issues encountered and recommendations to address these

Appendix B DPE-E&HG Annual Environmental Watering statement

DPE-E&HG provided the following report to the department and forms part of this annual review.

1. LIST OF ENVIRONMENTAL WATERING ACTIONS

In Table 1, provide a list of the environmental water actions undertaken using Prerequisite Policy Measures (PPMs) in the 2020-21 water year. In Attachment A, please provide the following supporting documentation for each event:

(a) Water Event Plan (Form A – Request to Deliver Environmental Water)
(b) Water Event Outcome (Form B – Environmental Water Delivery Report)
(c) Water Order

Table 1: List of environmental watering actions using PPMs in 2020-21

Event number (From Form A)	Event name	Targeted Valley
LOD20/21-01	Lower Darling-Baaka River Fish Flows	Lower Darling
LOD20/21-02	Lower Darling-Baaka autumn - winter flows	Lower Darling
MBG20/21-11	Native Fish Pulse MBG 2020/21	Murrumbidgee
MUR20/21-18	Multisite Hume to SA	Murray
MUR20/21-03	Edward/Kolety-Wakool River system	Murray

2. ENVIRONMENTAL OUTCOMES

In Table 2, provide a summary of the objectives of the environmental watering event and the extent to which these objectives were met. Please also provide information on the environmental outcomes observed to date, any ongoing monitoring of these outcomes and any relevant comments. Attach supporting documents in Attachment B.

Table 2: Summary of environmental outcomes

Event number	Event name	Environmental objectives	Degree to which environmental objectives were satisfied	Environmental outcomes observed or being monitored	Comments
LOD20/21-01	Lower Darling - Baaka River Fish Flows	Native Fish; Connectivity (flows and flooding); Native Vegetation; Ecosystem Functions; Other Species	Yes, the objectives were achieved	The flow supported Murray cod breeding by increasing the river flow through the breeding season. Recent monitoring confirmed strong breeding by Murray Cod in the spring of 2020, with high numbers of juveniles now present in the Lower Darling/Baaka.	This event aimed to support native fish recovery particularly Murray cod following the fish kills of 2019. The PPM applied to this event allowed for the use of CEW and TLM e-water from Menindee to SA border.
LOD20/21-02	Lower Darling (Baaka) autumn - winter flows	Connectivity (flows and flooding); Native Fish; Ecosystem Functions	Yes, the objectives were achieved	The flow supported Murray cod recruitment by increasing the amount of habitat available for juvenile Murray cod following a strong breeding response in spring 2020 (see above). Population surveys are due to be conducted spring 2021.	As above

Event number	Event name	Environmental objectives	Degree to which environmental objectives were satisfied	Environmental outcomes observed or being monitored	Comments
MBG20/21-11	Native Fish Pulse MBG 2020/21	Native Fish; Connectivity (flows and flooding)	Yes, the objectives were achieved.	This event facilitated fish movement opportunities between the Murray and Murrumbidgee Rivers. Balranald Weir in the Lower Murrumbidgee was drowned out for the majority of the migration season and provided connectivity to Tala and Yanga Lakes providing spawning and movement opportunities for native fish such as juvenile golden perch	The PPM applied to this event allowed for TLM water to be used in the Murrumbidgee for local outcomes as well as achieving outcomes in the Murray river system to SA. Water was delivered over 2 separate events.

Event number	Event name	Environmental objectives	Degree to which environmental objectives were satisfied	Environmental outcomes observed or being monitored	Comments
MUR20/21-03	Edward/Kolety-Wakool River system	Native Fish; Ecosystem Functions; Connectivity (flows and flooding); Other Species	Yes, the objectives were achieved	Environmental flows in this system provide opportunities for fish to disperse and colonise new habitats, access food resources and utilise suitable spawning habitats. Abundance of native fish including Murray cod and Silver perch has increased in recent years.	This event re-used flows delivered as part of the Multisite event (see below) and outside the multisite period a separate PPM in-channel use loss rate was applied. Note as per 2019-20 water year some of the water delivered for this event is delivered via the Murray irrigation system and is not covered by a PPM action therefore volumes reported by DPE-E&HG will be more than those reported by Water NSW.
MUR20/21-18	River Murray Channel Multi-Site 2020/21	Connectivity (flows and flooding); Native Fish; Ecosystem Functions; Native Vegetation; Waterbirds; Other Species	Yes, the objectives were achieved	The boost in flows between Hume and SA provided opportunities for native fish breeding and dispersal, colonial water breeding and maintenance of floodplain vegetation health.	This event inundated wetlands and floodplain creeks from the Hume dam all the way to the Murray mouth. The PPM allowed for e-water to be re-used at several sites along the way such as the Yallakool-Wakool and Colligen Creeks (see above).

3. STAKEHOLDER CONSULTATION

Section 5.1 of the PPMs Procedures Manuals states that the Annual Environmental Watering Statement must document "any feedback from consultation with stakeholders on the actions undertaken".

In Table 3, please provide a summary of stakeholder consultation. Attach supporting documents in Attachment C.

Table 3: Summary of stakeholder consultation

Date	Stakeholder forum/name	Environmental watering action/s discussed	Type of consultation	Summary of feedback	Stakeholder requests	List of supporting documents
October 2020	Murrumbidgee EWAG meeting and TAG subgroup	Native Fish Pulse MBG 2020/21	Teleconference	Group generally supportive of events and outcomes being achieved	none	
May and June 2020	MLD EWAG meetings	All Murray/Lower darling events	Teleconference	Group generally supportive of events and outcomes being achieved	none	

4. RECOMMENDATIONS TO IMPROVE FUTURE ENVIRONMENTAL WATERING ACTIONS

Section 5.1 of the PPMs Procedures Manuals states that the Annual Environmental Watering Statement must document "Any issues encountered in undertaking agreed actions, and any recommendations to address those issues or improve the operation of PPMs".

In Table 4, please provide a summary of key issues that arose in the ordering or delivery and accounting of environmental water during 2020-21, with recommendations for addressing these. Attach supporting documents in Attachment D.

Table 4: Summary of issues and recommendations

Event number	Issues related to the ordering, delivery and accounting of environmental water	Agencies involved	Stakeholders involved	Recommendations	List of supporting documents
LOD20/21-01	Nil				
LOD20/21-02	Nil				
MBG20/21-11	Nil				
MUR20/21-03	Currently the 70% loss applied in spring and 80% loss in summer seems very conservative to e-water holders.	E&H, CEWO		More accurate measurement of losses in the system	
MUR20/21-18	Nil				

Appendix C PPM work plan (for the 2020-21 water year)

The work plan below was discussed at the PPM Working Group meeting held 24 November 2020. A status update (as of February 2022) has been provided.

Task ID	Action	Responsibilities	Due	Work Plan Priority Status	Status (February 2022)
1.	Lower Darling Consider accounting for directed releases from MLS and return flows into the River Murray when MLS is under NSW control.	DPE Water	31 May 2020	High	Losses determined for in-stream deliveries (W32 to Burtundy)
2.	Murrumbidgee BED trial review: Finalise Murrumbidgee BED trial write up as supporting document for Murrumbidgee Publish review	DPE Water	June 2020	High	Final report is ready for publication
3.	Murrumbidgee Accounting for return flows from Murrumbidgee into River Murray (Balranald to SA border).	DPE Water, Technical working group	July 2020	High	Complete. Incremental loss approach finalised.
4.	Annual reporting templates Develop and finalise annual reporting templates to meet requirements of the Procedures Manuals: • Annual environmental release river operations report • Annual environmental watering statement • Annual evaluation and review report	WaterNSW & DPE-W DPE-E&HG & DPE-W DPE-W	June 2020	High	Done.
5.	Wakool River Refinement of accounting treatment subject to evaluation of 2019/20 event. Consider lessons learned from 2019-20 event.	DPE-W, Technical working group	July 2020	High	As water year progress, this action was given lower priority.

Task ID	Action	Responsibilities	Due	Work Plan Priority Status	Status (February 2022)
6.	Werai Forest Consider possible accounting treatment when: • Directed releases from Hume result in overbank flows into the forest incurring River Murray 20% loss. • Environmental flows reuse from the forest - possibly extend into Niemur.	DPE-W, Technical working group	August 2020	High	To progress.
7.	PPM WG meeting	PPM WG	August 2020	High	Not held.
8.	2019/20 reports – river ops reports: • Edward Kolety-Wakool return flow event • Millewa Watering event	WaterNSW	July-Sept 2020	High	Removed and included in the annual release river operations report
9.	2019/20 reports – environmental watering statements: • Edward Kolety-Wakool return flow event • Millewa Watering event	DPE-E&HG	July-Sept 2020	High	Removed and included in the annual release river operations report
10.	Review related work strands Review related work strands regarding loss treatment, and provide an overview report with recommendations to the WG: • Procedures Manuals for Active Management • Discussions with Victoria re losses in Murray • CEWO paper (Murrumbidgee losses)	Technical working group	October 2020	High	Not progressed.
11.	PPM WG meeting	PPM WG	October 2020	High	Held November 2020
12.	2019/20 report – annual evaluation and review: • Annual PPM evaluation and review report (2019/2020) • Provide recommendations to the PPM WG	DPE Water	Jan-March 2021	High	Complete.
13.	Lowbidgee weir pool filling Consider accounting treatment of environmental flows reuse to fill Lowbidgee weir pools to enable delivery of e-water into GNC, Yanga or Redbank.	Technical working group	Feb 2021	Moderate	As water year progress, this action was given lower priority. Consider in light of changes to water sharing plan.
14.	Mid-Murrumbidgee wetlands Accounting treatment of environmental flow reuse from Mid-Murrumbidgee wetlands to Balranald (e.g. targeting 13 GL/day at Darlington Point).	Technical working group	March 2021	Moderate	To progress.

Task ID	Action	Responsibilities	Due	Work Plan Priority Status	Status (February 2022)
15.	Beavers Creek/Old Man Creek anabranch Consider accounting treatment for Mid-Murrumbidgee wetlands.	Technical working group	April 2021	Moderate	Include in above.
16.	2021/2022 e-water priorities: Environmental water holders to provide e-water priorities for upcoming year	DPE-E&HG & CEWO	May 2021	High	Complete.
17.	PPM WG meeting	PPM WG	May 2021	High	
18.	Update annual work plan: • Update annual work plan based on e-water priorities Continue to build work plan using findings from reviews and previous years and e-water priorities	PPM WG	May 2021	High	Ongoing.
19.	Develop PPM Comms Plan Including ensuring all agencies making good on consultation requirements as set out in PPM Procedures Manuals	PPM WG	June 2021	High	Ongoing.
20.	Menindee Lakes Storage (NSW control): • Protection and accounting of undirected environmental flows to South Australia • Clarity in accounting for Menindee Lakes Storage releases when flow to SA is unregulated • Assumed loss rate applied to environmental deliveries in the Lower Darling • Anabranch releases.	DPE Water	June 2021	Moderate	Ongoing. Progressed assumed loss rate for in-channel delivers in the Lower Darling.
21.	Lowbidgee (Nimmie Caira; Redbank) Accounting treatment of environmental flows reuse from Lowbidgee wetlands to Balranald.	Technical working group	2021/2022	Moderate	Not progressed.
22.	Lowbidgee in-channel Consider accounting treatment and timing of directed release.	Technical working group	2021/2022	Low - Moderate	Not progressed.
23.	Yanco/Billabong/Forest Creek system Accounting treatment for in-channel deliveries and any environmental flow reuse into the River Murray.	Technical working group	2021/2022	Low - Moderate	Preliminary loss modelling complete.
24.	Lowbidgee water quality low dissolved oxygen Accounting treatment for directed releases aimed at mitigation of DO stratification in Lowbidgee	Technical working group	2021/2022	Low - Moderate	Not progressed.

Task ID	Action	Responsibilities	Due	Work Plan Priority Status	Status (February 2022)
25.	Wakool River (sourced from MIL escapes) Accounting treatment for environmental flows reuse from MIL escapes.	DPE Water & WaterNSW	2021/2022	Low - Moderate	Progress in next water year.
26.	Review approach for the assessment and mitigation of risks to all possible other water users and environmental water holders. Ongoing improvements to reduce the conservatism in assumed used methods to ensure all water entitlement holders are not unduly impacted or discriminated against.	Technical work group	2021/2022	Ongoing	Ongoing.
27.	Investigate and implement agreed alternative risk treatments as appropriate, such as: - post-event account reconciliation to ensure the environmental water use is accurate as possible and based on actual use where available. - progressively incorporate, where possible, incremental losses estimation methods, and transparent details where it is not used.	Technical work group	2021/2022	Ongoing	Ongoing.
28.	Reliability impact assessment in the Murrumbidgee for directed releases	DPE Water to lead	2021/2022	Low	Not progressed.
29.	Long-term modelling of PPMs	DPE Water, DPE-E&HG		Medium	Not progressed.

Appendix D Incremental loss method for return flows in the River Murray

This extract was taken from the Incremental Loss Method paper.

Introduction

Connectivity in the greater southern system is a key objective for Environmental Water Managers. Pre-requisite Policy Measures (PPMs) seek to maximise the beneficial outcomes of water recovered for the environment, including recognising environmental water throughout the length of the river, and between rivers. Accounting of environmental water delivered along the Murray regulated valley and over the South Australian border is important for recognising the volume of environmental water crossing the border and helping environmental managers make good decisions regarding effective use of held environmental water (HEW) accounts.

Understanding the relationship between flow conditions and losses is a key element of river forecasting and operations. Accounting and distribution of those losses have a significant influence on the system. This paper focuses particularly on the losses and recognition of volumes of HEW, as the greater the losses attributed to HEW, the more HEW may be required to achieve connectivity.

Previous methods took a proportional loss approach for all water delivery, where the total loss was determined and then apportioned to the volumes of HEW delivered. The proportional method overestimates the loss, as the total loss experienced by the system is considered to be caused equally by all water deliveries (e.g., irrigation diversion and South Australia's entitlement flow). This includes the HEW delivered from the Murrumbidgee, and results in a lower volume of environmental water recognised at the South Australian border. However, the bulk of the loss experienced by the system is due to normal River Murray deliveries. The addition of HEW from the Murrumbidgee in the Murray only results in an incremental increase in loss.

The incremental loss approach pre-calculates the likely losses, based on conservative conditions, without impacting other water users. Likely losses associated with different flow conditions are captured in a flow look-up table. Operators can assign losses for Murrumbidgee HEW entering the Murray to recognise the volume of environmental water at the South Australian border.

This paper describes the method used for accounting for losses to HEW that enters the Murray system from the regulated Murrumbidgee system as it travels through to the South Australian border. HEW accounting within the Murrumbidgee valley is out-of-scope and is dealt with through separate method. Later sections of the paper discuss the potential for applying this method to other HEW entering the Murray and other systems where a method for determining losses to HEW is required.

Method & requirements

The method presented here is used to calculate the losses to HEW based on the flow conditions during delivery, determined using historical loss data. This is the loss incurred as it travels through the Murray system. Analysis of historical flow and loss data results in a loss look-up table based on conservative estimates of losses in each flow range. This table can then be used to determine what losses to apply to HEW that has entered the Murray from an upstream tributary (in the initial implementation, the Murrumbidgee), when it reaches the South Australian border.

The method requires data sets of long-term daily flows and corresponding losses. This is typically obtained through a well-calibrated daily hydrological model of the system.

Data

The Murray Darling Basin Authority (MDBA) has developed a daily hydrological model (in SOURCE) for the River Murray system. The model outputs used in this analysis were from a model using historical data, which covered over 100 years of simulation. Loss data was extracted from this model covering the reaches from Boundary Bend to the South Australian border. Daily data was filtered to remove days on which large inflows from the Lower Darling would significantly impact the loss behaviour of this reach, resulting in about 70 years of simulation data remaining.

The daily data was separated into flow classes, with a summary of data available for these flow classes shown in Figure 1.

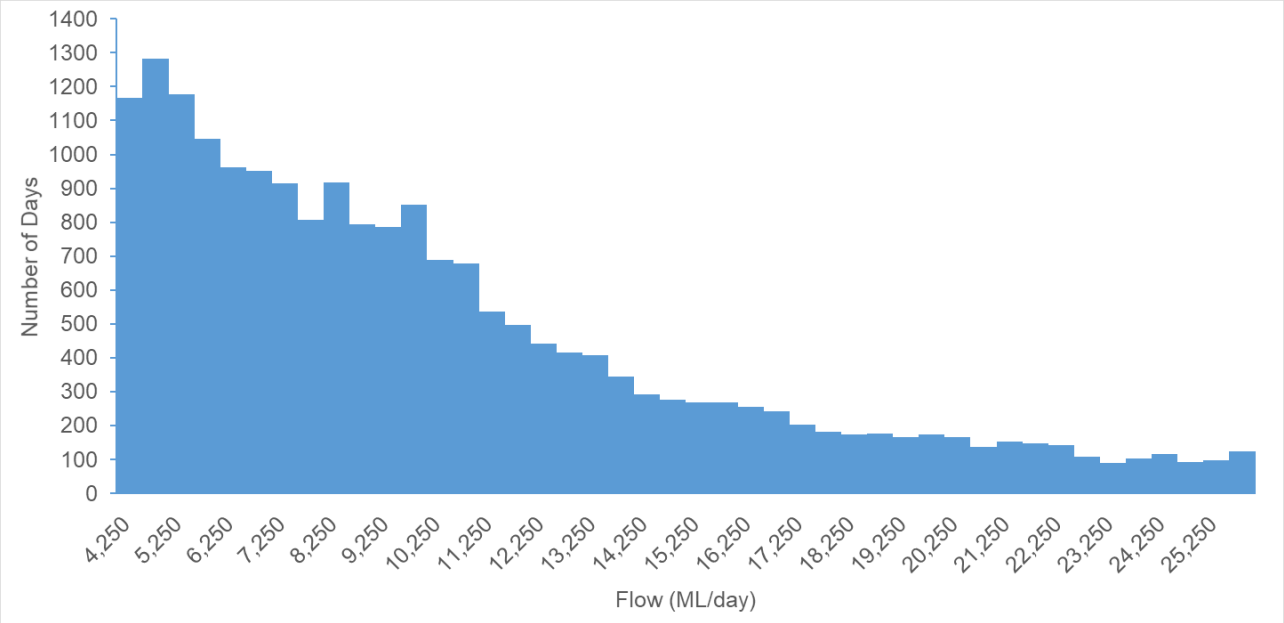


Figure 1: Days of data available by daily flow rate

Data was checked for uniformity of distribution within each flow class by comparing the mid-flow value of the flow range against the average flow within the class. Results showed that the average flow and the mid-flow values matched very closely, indicating likely uniform

distribution of datapoints, aiding in a smooth transitional behaviour in loss rates between classes.

Consideration must be given to the amount of data present in underpinning this analysis for a given flow. For example, as can be seen in Figure 1, greater than 500 days of data is available for flows below 12,000 ML/day, therefore, there is low risk of underestimating the losses. However, if a flow class has a small number of data points (<200 days), the confidence in the associated loss value is lower. This means the confidence in the method is lower when there are larger flows in the system, and higher confidence when there are smaller flows. Losses are of particular importance when only small volumes are moving through the system.

Incremental loss method

The incremental loss method analyses the daily losses experienced for each flow class range over 100 years, examines the range of values, and uses the most conservative losses to produce a loss look-up table for river operators.

To calculate incremental losses:

1. separate daily flow data into flow classes, keeping each data point with its associated loss value
2. analyse each flow class and determine loss values at key percentile intervals
3. create non-linear smoothing curves fitted to key loss percentiles across all flow classes
4. determine the rate of change for each curve (representing a particular loss percentile)
5. the incremental loss is determined by finding the cumulative rate of change along the smooth curve to jump from one flow class to another
6. the incremental loss for the flow class is the most conservative estimate. That is, the worst-case incremental loss is taken as the final incremental loss value associated with increasing flow from one flow class to another.

This loss analysis adopts a worst-case incremental loss to ensure other water users in the NSW Murray are not paying for losses for the delivery of HEW from the Murrumbidgee to the SA border. These incremental losses are significantly less than the proportional method used previously and demonstrates progress to accounting for losses resulting from the additional flow created by HEW moving through the system.

Results & implementation

The availability of uniformly distributed data resulted in a relatively smooth transition of loss values between classes for most loss exceedance plots (Appendix 1), but the loss function over several flow classes still showed rapid fluctuating changes. To smooth the loss function further, a 4th degree polynomial was fitted for each exceedance condition. This results in a smooth loss function for each exceedance condition (Figure 2), which shows consistent behaviour between flow classes within an exceedance condition, and also smooth transitional behaviour between exceedance conditions, ultimately aiding in the creation of a smooth loss look-up table.

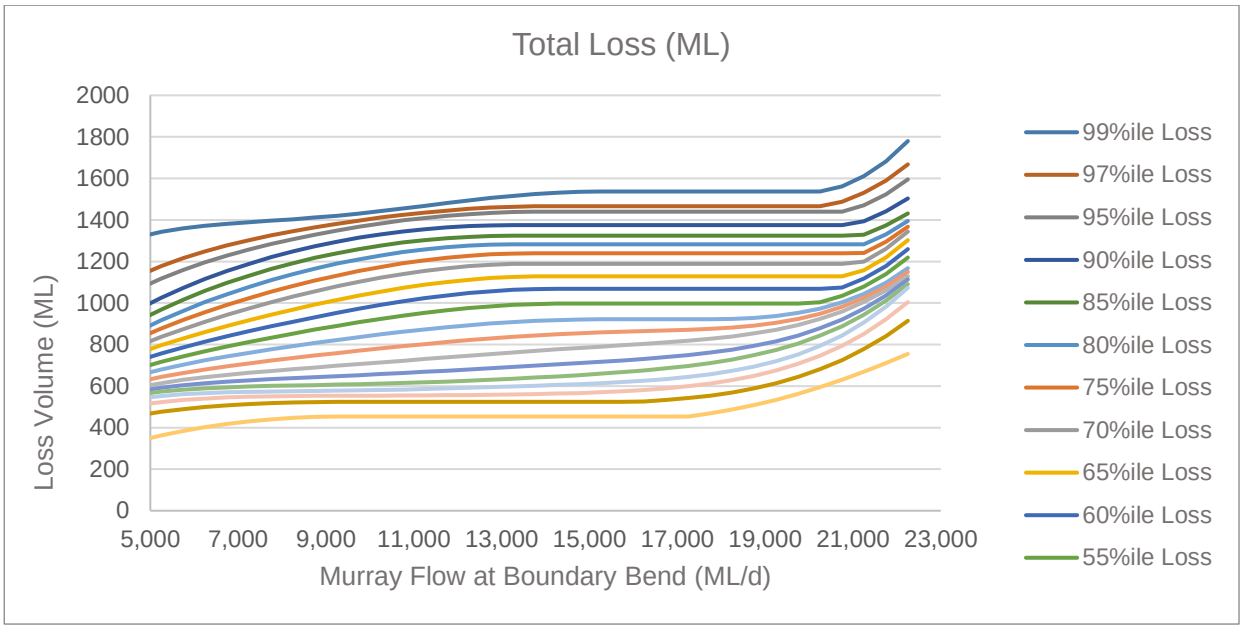


Figure 2: Loss volumes at various Murray River flow rates

Figure 3 shows the change in loss volumes between flow classes. It plots the incremental loss behaviour of each exceedance condition over all the flow classes and shows consistent, graduated differences between the various percentiles. Losses generally increase for all exceedance conditions for flows under 15,000 ML/day. For flows between 13,000 ML/day and 20,000 ML/day, exceedance conditions below the 50th percentile generally show a minimal increase in losses. All exceedance conditions show a rapid increase in losses for flows above 20,000 ML/day.

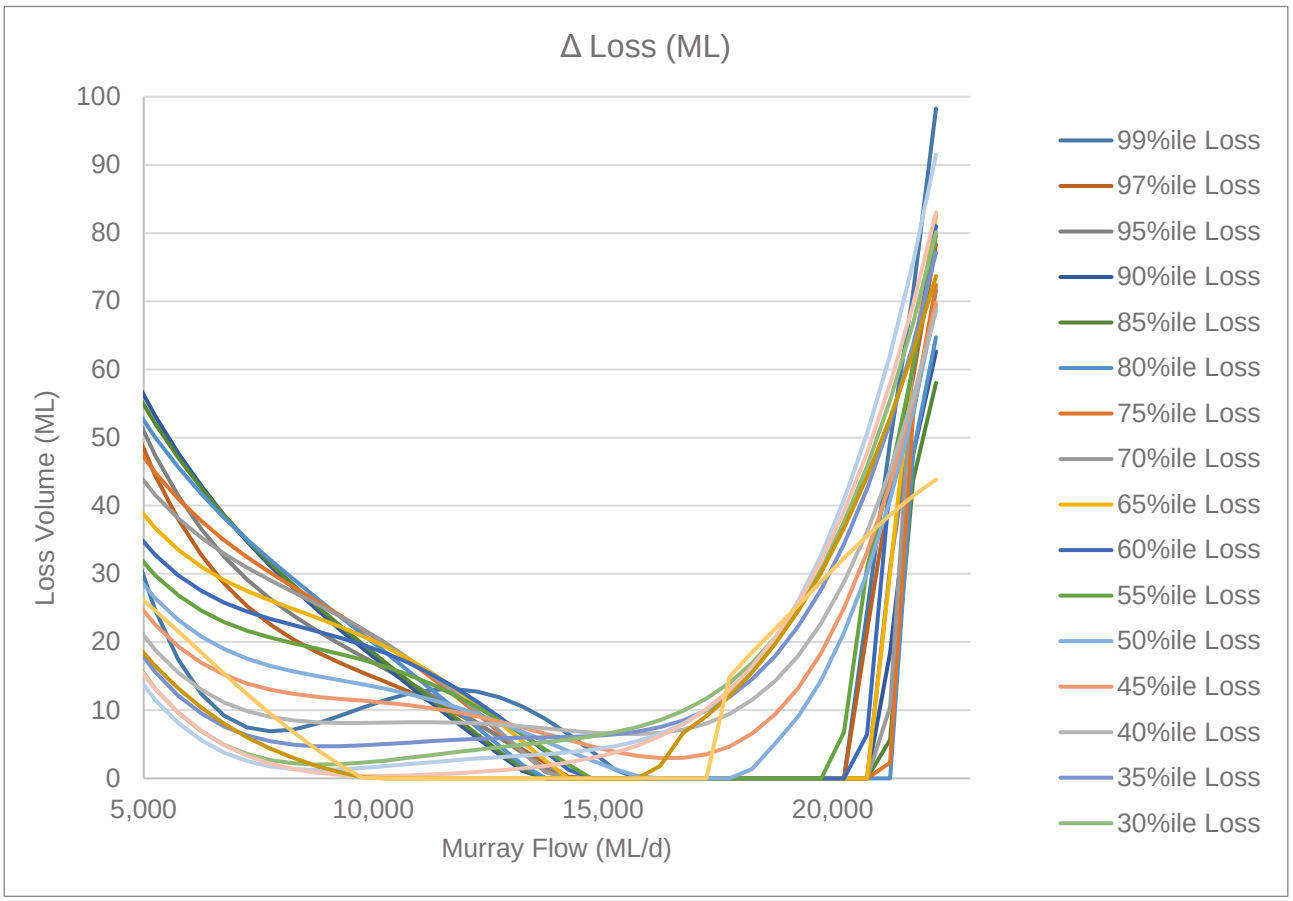


Figure 3: Change in loss volumes between flow rates

Seasonality and flow classes

The incremental loss analysis approach undertaken in this paper lumped all seasonal data together and used 500 ML/day increments. This analysis could have been undertaken on a seasonal basis, and with various different flow increments. Testing this method under various seasonal conditions and flow increments does not yield significant differences in the end results. Further analysis of seasonal data and flow increments may be part of a review process.

Table 1 shows the final incremental loss table. The table shows the River Murray is generally highly efficient in the flow ranges from 10,000-20,000 ML/day, with any increases in flow typically resulting in only a 2-5% increase in loss.

Operators can use Table 1 to look up a flow on a given day in the Murray River at Boundary Bend on the vertical axis, after removing the influence of the HEW being delivered from the Murrumbidgee River through Balranald. The HEW volume being delivered through Balranald is then taken from the horizontal axis. The corresponding value at the intersection of the appropriate vertical and horizontal axis values is the loss value which can be applied to the HEW being delivered that day.

Extending implementation to the Lower Darling

The data which underpins the analysis of losses in the Murray for this implementation is from Boundary Bend to the South Australian border. It is only applicable to flows in the Murray system within this reach.

Scaling these results to represent a subset of this reach (e.g. from the Lower Darling to South Australian border), in lieu of further dedicated analysis, would be the most appropriate extension of application of this analysis. Held environmental water entering the River Murray would be assigned a proportion of the losses that environmental water from the Murrumbidgee would experience between entering the Murray and the border. This would be the most efficient path to implementation and would also prevent the introduction of discrepancies that may be caused by random data fluctuations and effectively analysing losses along the same reach twice, without resulting in any additional accuracy.

The results in Table 1 could be scaled to represent loss behaviour over other reaches along the River Murray; however, increasing variation in reach geomorphology and climate conditions as compared to the reaches used in this analysis will lead to increased errors and reduced accuracy.

The incremental loss method is highly dependent on high quality, long-term, flow and corresponding loss data. A well-calibrated daily flow model, with realistic loss to flow relationships is the most likely source of this data. The MDBA Murray model is fit for this purpose. If we wished to apply a similar approach to recognising losses in other systems, an appropriate hydrological model with similar levels of climatic input data would be required.

Future work to incorporate climate change

The incremental loss method is based on conditions experienced during the last 100 years. Stochastic climate modelling work being done for Regional Water Strategies could help examine whether the range of losses experienced during the model run is likely to be sufficiently broad to cater for future climate variability.

The incremental loss analysis could be periodically performed with extended model data to ensure the conservative loss volumes captured in the look-up table are still reflective of Murray flow conditions.

The incremental loss method could be used in reaches where recognition of environmental water entering from tributaries is a priority.

Table 1: Loss look-up table for Murrumbidgee water (HEW) entering the Murray

Murray	Incremental Loss Vol (by Murrumbidgee Return Vol)										Incremental Loss % (by Murrumbidgee Return Vol)									
Flow Range	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000
4000 - 4500	65	124	176	223	266	305	339	370	397	421	13.0%	12.4%	11.7%	11.2%	10.6%	10.2%	9.7%	9.2%	8.8%	8.4%
4500 - 5000	124	176	223	266	305	339	370	397	421	442	24.9%	17.6%	14.9%	13.3%	12.2%	11.3%	10.6%	9.9%	9.4%	8.8%
5000 - 5500	111	158	200	239	273	304	331	355	378	398	22.2%	15.8%	13.3%	11.9%	10.9%	10.1%	9.5%	8.9%	8.4%	8.0%
5500 - 6000	100	142	180	215	245	274	299	323	343	361	20.0%	14.2%	12.0%	10.7%	9.8%	9.1%	8.5%	8.1%	7.6%	7.2%
6000 - 6500	90	128	163	194	223	250	273	294	310	325	18.0%	12.8%	10.9%	9.7%	8.9%	8.3%	7.8%	7.3%	6.9%	6.5%
6500 - 7000	81	116	149	177	204	227	248	265	279	290	16.3%	11.6%	9.9%	8.9%	8.1%	7.6%	7.1%	6.6%	6.2%	5.8%
7000 - 7500	74	106	135	162	185	206	222	237	250	260	14.7%	10.6%	9.0%	8.1%	7.4%	6.9%	6.3%	5.9%	5.5%	5.2%
7500 - 8000	67	97	123	146	167	184	200	213	224	232	13.4%	9.7%	8.2%	7.3%	6.7%	6.1%	5.7%	5.3%	5.0%	4.6%
8000 - 8500	62	88	111	132	151	167	180	191	199	204	12.3%	8.8%	7.4%	6.6%	6.0%	5.6%	5.2%	4.8%	4.4%	4.1%
8500 - 9000	55	79	101	120	136	151	162	169	174	176	11.0%	7.9%	6.7%	6.0%	5.5%	5.0%	4.6%	4.2%	3.9%	3.5%
9000 - 9500	51	73	91	109	122	133	141	146	150	150	10.1%	7.3%	6.1%	5.4%	4.9%	4.4%	4.0%	3.7%	3.3%	3.0%
9500 - 10000	46	66	83	96	107	117	122	125	128	128	9.2%	6.6%	5.5%	4.8%	4.3%	3.9%	3.5%	3.1%	2.8%	2.6%
10000 - 10500	42	58	73	85	94	100	105	110	114	117	8.4%	5.8%	4.8%	4.2%	3.7%	3.3%	3.0%	2.8%	2.5%	2.3%
10500 - 11000	36	51	63	73	81	90	98	102	103	103	7.3%	5.1%	4.2%	3.6%	3.3%	3.0%	2.8%	2.6%	2.3%	2.1%
11000 - 11500	32	44	56	67	77	84	88	90	90	90	6.4%	4.4%	3.7%	3.4%	3.1%	2.8%	2.5%	2.3%	2.0%	1.8%
11500 - 12000	29	42	53	63	69	74	76	76	80	88	5.7%	4.2%	3.5%	3.1%	2.8%	2.5%	2.2%	1.9%	1.8%	1.8%
12000 - 12500	28	39	48	55	59	62	64	70	78	88	5.5%	3.9%	3.2%	2.8%	2.4%	2.1%	1.8%	1.8%	1.7%	1.8%
12500 - 13000	24	34	42	46	47	55	62	69	78	94	4.8%	3.4%	2.8%	2.3%	1.9%	1.8%	1.8%	1.7%	1.7%	1.9%
13000 - 13500	21	29	33	39	46	53	62	74	89	108	4.2%	2.9%	2.2%	1.9%	1.8%	1.8%	1.8%	1.8%	2.0%	2.2%
13500 - 14000	17	23	31	37	45	55	68	84	102	124	3.3%	2.3%	2.1%	1.9%	1.8%	1.8%	1.9%	2.1%	2.3%	2.5%
14000 - 14500	15	22	30	39	50	62	77	96	119	146	3.1%	2.2%	2.0%	1.9%	2.0%	2.1%	2.2%	2.4%	2.6%	2.9%
14500 - 15000	14	22	32	43	56	72	90	112	140	174	2.9%	2.2%	2.1%	2.1%	2.2%	2.4%	2.6%	2.8%	3.1%	3.5%
15000 - 15500	15	25	36	50	64	83	106	133	167	209	3.1%	2.5%	2.4%	2.5%	2.6%	2.8%	3.0%	3.3%	3.7%	4.2%
15500 - 16000	18	29	42	57	76	98	125	160	201	253	3.5%	2.9%	2.8%	2.9%	3.0%	3.3%	3.6%	4.0%	4.5%	5.1%
16000 - 16500	20	33	48	67	90	118	152	193	246	316	4.0%	3.3%	3.2%	3.4%	3.6%	3.9%	4.3%	4.8%	5.5%	6.3%
16500 - 17000	24	40	58	80	108	142	184	240	308	392	4.8%	4.0%	3.9%	4.0%	4.3%	4.7%	5.2%	6.0%	6.8%	7.8%
17000 - 17500	29	47	69	97	131	175	231	299	383	483	5.7%	4.7%	4.6%	4.8%	5.2%	5.8%	6.6%	7.5%	8.5%	9.7%
17500 - 18000	36	61	89	121	164	220	288	372	472		7.3%	6.1%	5.9%	6.1%	6.6%	7.3%	8.2%	9.3%	10.5%	
18000 - 18500	44	73	106	150	206	274	358	458			8.8%	7.3%	7.0%	7.5%	8.2%	9.1%	10.2%	11.4%		
18500 - 19000	52	87	132	188	256	340	440				10.3%	8.7%	8.8%	9.4%	10.3%	11.3%	12.6%			
19000 - 19500	65	110	165	233	317	418					13.0%	11.0%	11.0%	11.7%	12.7%	13.9%				
19500 - 20000	81	136	205	288	388						16.3%	13.6%	13.6%	14.4%	15.5%					
20000 - 20500	100	169	252	353							20.0%	16.9%	16.8%	17.7%						
20500 - 21000	124	207	308								24.9%	20.7%	20.5%							
21000 - 21500	152	252									30.4%	25.2%								
21500 - 22000	187										37.4%									
22000 - 22500																				